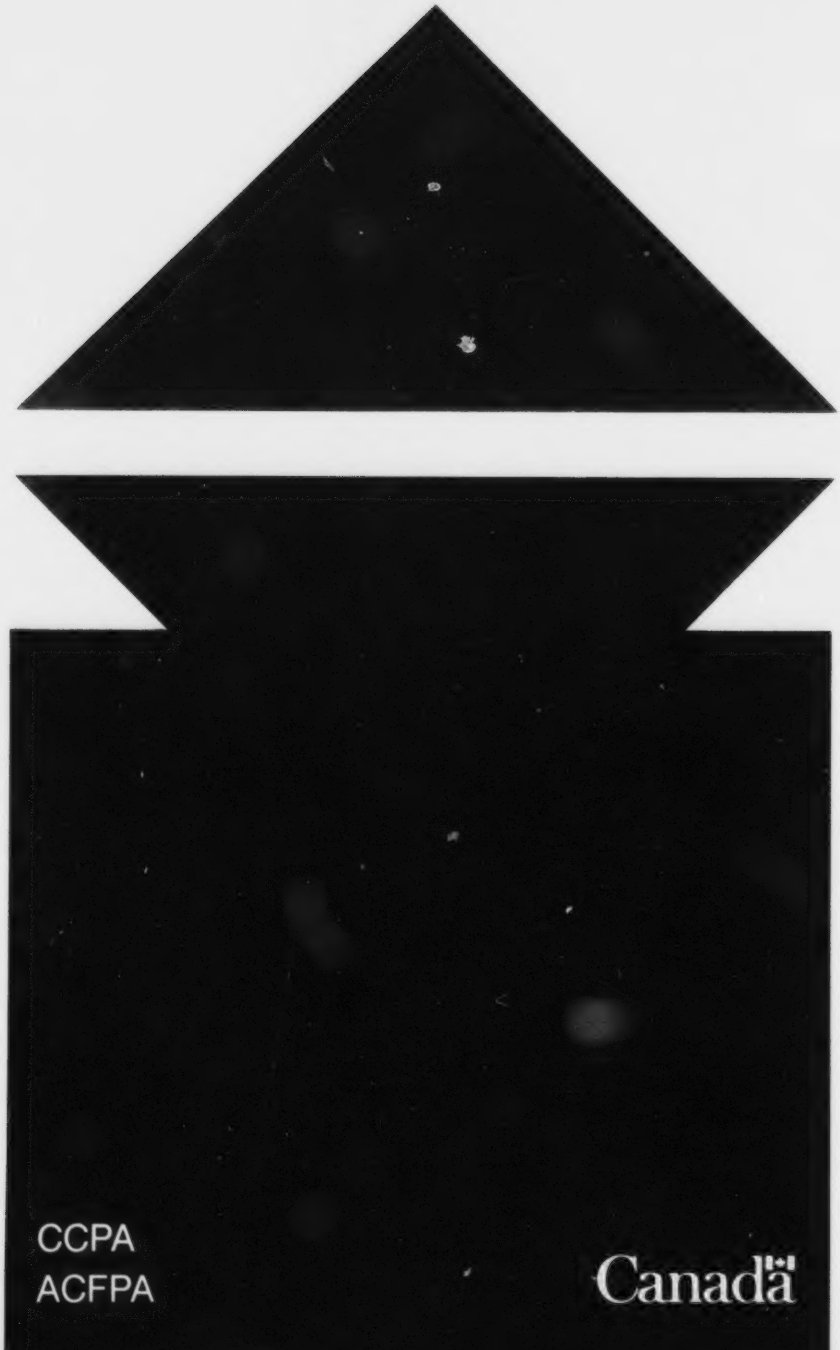
Marchandises dangereuses
Intervention d'urgence

Dangerous Goods
Emergency Response

'89



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PROCEEDINGS

DANGEROUS GOODS EMERGENCY RESPONSE '89

May 16 - 18, 1989
HALIFAX SHERATON,
HALIFAX, NOVA SCOTIA,
CANADA

COMPTES RENDUS

MARCHANDISES DANGEREUSES INTERVENTION D'URGENCE '89

16 au 18 mai 1989
L'HALIFAX SHERATON,
HALIFAX (NOUVELLE-ÉCOSSE)
CANADA

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The Canadian Chemical Producers' Association
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The Steering Committee wishes to record its appreciation of the efforts of the panelists for preparing the outlines of their papers and their subsequent delivery and to the panel moderators for guiding panelists and audience during the conference sessions.

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Le comité d'organisation aimerait noter son appréciation auprès des conférenciers pour la préparation ainsi qu'aux modérateurs pour leur aide soutenue lors du déroulement de la conférence.

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EMERGENCY RESPONSE TO CHEMICAL INCIDENTS IN CANADA

Mr. Jean Bélanger, President
The Canadian Chemical Producers' Association

On behalf of The Canadian Chemical Producers' Association, one of the co-sponsors of this conference, I would like to welcome you to this important international meeting.

I am confident that our common goal of sharing information on new methods and technological advances for responding to transportation emergencies involving dangerous goods will bear fruit and lead to further innovation domestically and internationally.

To begin, let me briefly discuss and describe to you what our Association is, and what it stands for within the context of this conference.

The Canadian Chemical Producers' Association, CCPA for short, is comprised of 73 member companies operating more than 200 plants in 115 communities across Canada.

The Association's mission is to assist the Canadian chemical industry to achieve domestic and international competitiveness through strategic involvement in the public policy process; by providing members with counsel in response to Canadian social needs and maintaining the industry's relevance and public support; by representing the industry and its interests with governments, other industries and public interest groups; and by supporting the industry's position related to environmental concerns.

Our member companies manufacture about 90 per cent of the chemicals made in Canada. Total value of this production is between nine and ten billion dollars every year and 40 per cent of this is earmarked for export. About two-thirds of exports are to the United States - much of it by road and rail.

Chemical manufacturing is the fifth largest industrial sector in Canada, behind petroleum refining, pulp and paper, motor vehicle manufacturing and meat processing.

The fact our industry has such high economic performance means we must also have a proactive social orientation, especially in light of some of the major disasters that have plagued the chemical industry. We all know them - Bhopal, Mississauga, Flixborough, Love Canal and, more recently, St. Basile le Grand.

This brings me to what our Association stands for in light of this conference. As you all know, the 1984 chemical disaster in Bhopal, India had a profound awakening effect on the chemical industry around the world. It brought into immediate question all the practices and procedures on which the industry relied - in which it had confidence - and on which its safety record had been built. In the words of the chairman of Union Carbide Canada when addressing a CCPA emergency board meeting on the subject - "The unthinkable has happened."

We immediately asked our membership to assess their operations to ensure that a similar event would not occur here, and to confirm that this had been done. In addition, we commissioned two task forces to address two distinct but related areas: a process whereby our members could thoroughly examine their plant operations within the context of a Bhopal-type accident; and a process whereby we would be able to speak publicly about managing our products and processes responsibly - through all the various stages of their life cycles. These projects were known as "Safety Assessment" and "Responsible Care" respectively.

Safety Assessment addressed preventive action and contingency planning both internally and externally to the plant. Its mandate was to provide a process by which member companies could assure themselves of the safety of a plant and the ability to manage incidents which impacted on the plant and on the community as well.

We then asked our membership to report back with their findings. Without getting into details, let me just say we identified areas for improvement. And it came as no surprise that as we were developing the Safety Assessment process, we were in fact creating the genesis of our Community Awareness and Emergency Response initiative, known as C.A.E.R. - or CAER.

When the Bhopal aftermath review report was published in 1986, we were already receiving safety assessment reports from our members and we were considerably advanced in developing implementation materials for our Community Awareness and Emergency Response initiative.

The Bhopal report recommended that we make safety assessment available to others, and that we implement a CAER program similar to the one developed by the Chemical Manufacturers' Association in the United States. Members of our Safety Assessment Task Force saw the program as a natural part of any activity concerned with a chemical incident with potential impact on the community.

The goals of the CAER program are to have a plant community informed about its chemical industry, and that there be an emergency response plan which can deal with any man-made or natural disasters. I'm delighted to say that, to date, 87 per cent of member sites have had some dialogue with communities regarding emergency response planning. And 47 per cent of our sites are members of a community emergency response planning committee.

As an industry association, we have plunged our membership into the process of community emergency response planning. We have done so not only to bring expertise to the planning process - but to act as catalysts. We have asked our members to actively participate through a community awareness and emergency response code of practice intended to apply to all their facilities in Canada.

This code of practice clearly states that each research and development, manufacturing, storage, and disposal site must have an active community awareness and emergency response program. It requires an up-to-date operational emergency plan based on a site-specific risk assessment. This emergency plan must identify those situations where company materials or processes could have an impact upon the community in the event of an emergency.

Earlier in my remarks, I mentioned a Task Force formed to develop Responsible Care standards. Quite some time prior to the Bhopal incident, the CCPA had presented a set of guiding principles to our membership.

Immediately following Bhopal, our board passed a resolution that required formal corporate commitment by member companies to these guiding principles as a condition of membership in the Association. These principles formed the basis to create a comprehensive set of codes of practice. They have been completed, approved by the CCPA Board of Directors, and endorsed by member companies. I have already discussed one of these codes - Community Awareness and Emergency Response.

The second code - dealing with transportation - has been launched with a series of seminars and supporting materials. The program is called TRANSCAER, analog to CAER. Both contain preventive actions. CAER has safety assessment; TRANSCAER has a motor carrier evaluation process. Both have contingency planning. CAER has community emergency response planning. TRANSCAER has transportation emergency assistance planning. As many of you are first responders to emergencies, I will deal with CCPA's Transportation Emergency Assistance Plan (TEAP) shortly in more detail.

In addition to these two codes, there are also codes of practice dealing with research and development, manufacturing, distribution and hazardous waste management.

These codes of practice are designed to put substance behind the guiding principles to which our members are signatories.

Supporting members companies' emergency response commitments under the Transportation Code of Practice is the CCPA's TEAP. TEAP was originally established in 1971 to provide technical information to emergency forces at the site of transportation mishaps involving chemicals, and to alert shippers to the emergency situation. TEAP's original mandate did not require the dispatch of emergency teams to the site although teams were, in fact, sent whenever needed. In 1982 TEAP was expanded into a truly national mutual aid response system supported by regional response centres located on main transportation arteries across Canada. Under federal regulations every owner-shipper of items on a special list of dangerous goods must have an approved emergency response plan as a condition of the right to ship these goods in Canada. TEAP fully meets this legal requirement.

While CCPA member companies have their own response plans, TEAP is a mutual aid plan for providing members with a faster initial response capability across Canada. Trained and equipped emergency response teams maintained by CCPA member companies are located at eleven regional response centres across Canada and within six hours of most points along our major transportation corridors. On request from a TEAP member these teams provide an initial response to transportation emergencies until relieved by a team from the requesting company.

A major initiative in strengthening TEAP is currently under way. To supplement regional response centres, voluntary response centres are being added to TEAP's response network. Voluntary response centres, maintained by TEAP members, will be available to provide a voluntary response within the capabilities of their resources. Some twenty voluntary response locations have been identified which will substantially strengthen an already effective emergency response plan.

CCPA's TEAP Committee is continually assessing training needs of our members' emergency response teams. Programs are now in place for continued training of TEAP technical advisors through courses at Lambton College in Sarnia. As a matter of interest to many of you here today, while these courses are primarily aimed at TEAP members they are open to anyone interested in emergency response. In fact, we believe that the greatest single need for improved emergency response in Canada is more extensive and consistent training of first responders, particularly voluntary emergency response forces. To this end TEAP members are working on a national multipartite task group on first responder training.

You can see that the Canadian Chemical Producers' Association and its member companies are very serious about safely storing, handling, transporting and producing chemicals in Canada. We have and are continuing to respond to public needs in every way possible and our strategy, as outlined here today, is to work closely with all concerned in chemical transportation - whether they are emergency forces, or highway or railway personnel.

We welcome the opportunity to discuss the CCPA's programs with you to improve wherever possible the methods of handling chemicals and maintaining our industry's enviable safety record.

Introductory Comments

J.A. Read
Director General

Transport Canada
Transport Dangerous Goods Directorate

Transport Canada's primary responsibility is safety during transportation and this naturally includes the safe transportation of dangerous goods. The Dangerous Goods Directorate of Transport Canada has as its primary role the reduction of risk in Canada relating to the transportation of dangerous goods.

To carry out our role we first view risk as a combination of the probability of a release of a dangerous product and the consequences of that release. With respect to the probability of release our regulations are directed toward training, handling, and packaging. With respect to consequences our regulations relate to emergency response assistance plans, product identification, marking and the provision of emergency direction and advice.

During the course of this conference there will be discussion on and progress made with the review of Emergency Response Assistance Plans. In passing I note Exxon has put forward government approval of their emergency response assistance plan as a defence for the level of response activity they provided in Alaska. Obviously these plans require careful review. In addition there will be discussions on the activities conducted by CANUTEC setting out the success which that unit is having in providing timely and accurate response advice.

As we hear so often, good emergency response depends upon good planning and this is supported totally by the dangerous goods directorate. Events such as this emergency response conference form a part of the planning which leads us toward a safer system.

I am very pleased to be able to welcome each of you to this conference, but before passing on the floor to the next speaker, and as there is no place later in the conference, I would like to make two quick comments on two initiatives now underway in Transport Canada. The first of these has resulted in Transport Canada producing a consolidated computerized set of dangerous goods regulations. This is in Macintosh and IBM format and will be distributed at least through the Canadian Centre for Occupational Health and Safety's CCINFO DISK. This automated version will be updated on the day of coming into force of any new amendments and the result will be an accurate consolidated version of regulations, searchable through the various word search techniques and which we hope will go a long way toward easing the difficulty of searching our regulations. The second initiative is the project to test the feasibility of developing, using computer artificial intelligence, a dangerous goods advisor which can be used to interpret the regulations. The first phase of this project, to cost approximately two hundred thousand dollars, has begun, and if successful we will then move to an expanded version. The dangerous goods advisor would be available at our regional offices and also to the public at least on a bulletin board system.

With these two initiative we are once again placing an emphasis on reducing the probability of accidents. With this present conference we expect to find ways to reduce consequences.

ADDRESS ON BEHALF OF ENVIRONMENT CANADA

Mr. James Vollmershausen
Director General Atlantic Region
Conservation and Protection
Environment Canada

I welcome the opportunity to address this the second international conference on dangerous goods emergency response.The first session you will remember was held in Vancouver during Expo 86.The theme of Expo was transportation;it is fitting therefore that we should now have spanned the country to convene here in Halifax in 1989.

You will agree I am sure that a lot has happened in the intervening years;I would like to briefly highlight some of these events,the changes they have brought about and some of the activities of Environment Canada in the field of emergency response through these exciting times.

The Canadian public,if one is to believe the pollsters, has always placed a very high priority on environmental issues in general and on the need for environmental protection in particular. The run up to the recent federal election, however, was unprecidented in heightening and focussing the attention of the media and our elected officials on environmental matters. This increased awareness of our environment has been triggered not only by events within Canada but also by international actions and initiatives such as the report of the Brundland Commission on the Global Environment ,fear of the greenhouse effect,international dumping of toxic wastes and here,in Canada,by the continuing dialogue with the U.S. on the need to control acid rain and the recent introduction of the Workplace Hazardous Material Information System.

There have been a number of major environmental emergency incidents here in Canada since our last meeting.These,I believe,have added to the momentum. In particular I would highlight the evacuations of people required in response to a pesticide warehouse fire in Canning,here in Nova Scotia in 1986; the explosions and resulting fires due to gasoline vapours leaking into the sewer system of Saint John, New Brunswick in the same year;and the Sainte-Basile-Le-Grande PCB warehouse fire east of Montreal in September of last year in which over 3,000 people were evacuated for an extended period of time. Even more recently,the bunker oil spill which contaminated the west coast of Vancouver Island and the one closer to home which killed hundreds of seabirds in Placentia Bay, Newfoundland.

Environment Canada,along with many other agencies has participated in the response and clean-up of these and many more emergencies ; each one has taught us something new and lead to additional improvements in our preparedness and our response.As a result of the Canning incident, for example, a task force was established by the Nova Scotia Provincial government and from the work of this taskforce new laws and procedures for the safe handling of hazardous materials are being implemented.During that incident,Environment Canada was able to test and refine a cooperative system for conducting and verifying the accuracy of environmental samples on a priority basis at laboratories from five different federal agencies. The Department was also able to evaluate and confirm,under harsh field conditions,the capabilities of a newly developed filtering technology,known as reverse osmosis.This technology can remove contaminants such as pesticides from large volumes of water resulting from firefighting and site clean-up operations.The Saint-Basile-Le-Grande fire has shown the need to further improve the regulatory regime surrounding the handling and storage of PCB's and the need to act decisively in the destruction of present stockpiles of this persistent chemical.Federal and provincial regulations have been revised and portable PCB destruction units leased.Local fire services and municipal bodies have been provided with information on storage sites and the sites have been rigorously inspected to ensure compliance with the new rules.

Not only have we been active in spill response,during the past year many of us also participated in CANUSLANT,a major exercise of Canada/US response capabilities held in Saint John,New Brunswick.This exercise tested and reinforced the value of coordinated international efforts in emergency response and in particular confirmed the need for joint evaluation of environmental matters in times of emergency.It also identified communication among the various agencies involved as an area requiring improvement The use of mini-computers to pass information and advice was viewed as an appropriate solution to this problem.

Perhaps one of the most significant measures taken by Environment Canada during the last 3 years in response to toxic chemical problems has been the passage and implementation of the New Canadian Environmental Protection Act (CEPA). This legislation enacted in June of 1988 brings together into one package the Departments acts and regulations dealing with toxic chemicals and hazardous wastes.It expands federal regulatory powers so that more realistic and very substantial penalties can be imposed for offences against the environment,and provides for more public input to the regulatory process. The Department has developed a clear and concise enforcement and compliance policy to accompany CEPA and is similarly developing such a policy for the pollution control provisions of the Fisheries

Act to ensure fair, but firm and consistent, treatment of polluters across the country.

The Department continues to be active in the field of R&D, developing, evaluating and demonstrating new equipment and procedures for preventing,detecting, measuring ,responding to and cleaning up oil and hazardous material spills.On an ongoing basis we test new spill treating agents as well as the toxicity of spilled chemicals.The findings of these studies are published and readily available through our regional office in Dartmouth.

Environment Canada also maintains a detailed computer data base of all significant spills in Canada since 1974.This computer system is presently being upgraded to facilitate the recovery and analysis of information from this valuable source .Such information is extremely useful in the assessment of spill trends and the establishment of effective prevention programs.

We have an ongoing program in conjunction with other federal and provincial agencies to train initial responders such as police, firefighters and industry representatives to respond safely and effectively to all manner of environmental emergencies. Over the past several years such training requirements have mushroomed as industries and municipalities develop and equip specialized hazardous material response teams of their own.

Conferences such as this one provide a vital forum for exchange of information on emergency response .I am very pleased to be able to share the podium with other conference sponsors and with representatives from MIACC (Major Industrial Accident Coordinating Commitee) and TEAP (Transportation Emergency Assistance Plan).I would like to acknowledge the initiatives being taken in the Halifax\Dartmouth area,on behalf of chemical industries,to develop a Community Awareness Program (CAER).Increased public awareness of the activities and facilities of the chemical industry can work to allay fears and suspicions that have built up over the years.

I would like to thank the organizers for inviting me to speak to you today.I trust the upcoming conference sessions will prove productive and that those of you from outside the province will take full advantage of the local scenery and hospitality.Thankyou.

EMERGENCY RESPONSE IN CANADA

T. D'Arcy Finn, Q.C.
Executive Director, Emergency Preparedness Canada

At a recent international congress held in London, England, attended by representatives of 40 nations to exchange information on emergency preparedness, one of the most engrossing presentations was given by the Medical Adviser to the Swiss-based International Civil Defence Organization. Using statistics, he showed graphically that in countries where measures for meeting the effects of natural and technological hazards have been instituted, the percentage of injuries, death and damage has been reduced dramatically. If we ever needed a persuasive argument for spending money up front on emergency preparedness and public awareness, this is it.

Such thinking mirrors the philosophy of Emergency Preparedness Canada and is enunciated in the preamble to Canada's new Emergencies Act. This states: "The safety and security of the individual, the protection of the values of the body politic and the preservation of the sovereignty, security and territorial integrity of the state are fundamental obligations of government."

One of the objectives of the organization I head is to encourage a uniform standard of emergency preparedness across the country to minimize the results of natural and human-made disasters. We do this in a number of ways, including funding joint projects with the provinces and territories, through public awareness, training and education, and through sharing the results of research.

We are not a big federal department, although we have a big job to do. And what we do, forms the umbrella for the federal response to emergencies, including those arising out of the manufacturing, storage and transportation of dangerous goods.

Unlike some national emergency organizations, Emergency Preparedness Canada does not normally manage the response to emergencies. Rather, we are responsible for co-ordinating the development of federal civil emergency plans to an appropriate state of operational readiness to meet emergencies.

Civil emergency planning in Canada is based on an all-hazards approach and on the premise of graduated response.

The all-hazards approach is based on the fact that the effects of disasters are generally similar, regardless of the cause: people are left homeless, require medical attention, food, clothing and shelter.

First, it is up to the individual to know what to do in an emergency. If the individual cannot cope, the local municipal government takes over. It is the responsibility of each Canadian mayor to ensure that his or her city has an emergency plan to cope with the events most likely to affect the city. Incidents involving the transportation of dangerous goods would be on the list of many cities, especially if they are on major transportation routes.

In an incident involving dangerous goods (or for any other kind of emergency), if help is required from surrounding municipalities, or from the provincial government, it is requested and provided in accordance with a pre-arranged plan.

If the emergency cannot be managed within the province or territory, or if, by the nature of the emergency, it has federal or national implications, then the resources of the federal government can be brought to bear.

The Government of Canada works on the lead agency principle when responding to crises. Each department, agency and Crown corporation is required to plan and prepare for emergencies related to its normal area of responsibility. For most emergencies, it is known in advance which department or agency will take the lead role in the federal response. For example, in airport crashes, it would be Transport Canada, while for Chernobyl-type releases of radioactive material, it would be Health and Welfare Canada. However, when the lead department or agency is not obvious, the Prime Minister will name a Minister and thus, a department to assume the lead on behalf of the federal government. In many incidents, such as a fire in a warehouse storing PCBs, the role of the federal lead department would be to co-ordinate field support for the provincial government. This could take the form of analysing soil, air and water samples to determine the degree of contamination; or federal help could lie in providing, or arranging the provision of, special equipment or transportation to help deal with the problem.

In any serious incident, including those involving dangerous goods, Emergency Preparedness Canada staff at the Government Emergency Operations Co-ordination Centre are among the first to know about it. The Centre is in our headquarters in Ottawa. Staff monitor the news media and scan reports from a network of provincial and federal contacts. Our sophisticated state-of-the-art equipment ensures rapid gathering and dissemination of information to the appropriate federal departments and agencies.

If a federal response is required, the Centre, which functions around the clock, can serve as an electronic focal point for emergency government operations. The Co-ordination Centre is a channel for operational communications, and a place from which senior officials can co-ordinate support, analyze the situation, and respond to changing emergency conditions.

The best defence, to prevent emergencies from becoming disasters, is preparedness: good planning, exercising those plans, training your people, mapping out the scenario in advance, knowing what to do and who will do it, are keys to mitigation and rapid response. We instill these principles in the 110 courses given at our Emergency Preparedness College about 40 miles west of Ottawa. We give courses to 3,000 people annually, many of them mayors and elected officials. We tell them about their responsibilities in emergencies and teach them how to analyze the hazards, how to draw up a plan and how to implement it. We receive a surprising number of letters from those who have been on our courses.

In the aftermath of the Bhopal tragedy, we in Canada formed a committee comprising representatives from government and industry to examine the potential for major industrial accidents in Canada and to improve the collective ability to prevent and respond to such incidents. In May 1987, at the instigation of Emergency Preparedness Canada and a fellow department, Environment Canada, and working closely with provincial colleagues, it was decided to strike a steering committee as a prelude to forming the Major Industrial Accident Co-ordinating Committee (MIACC). My organization helped arrange a meeting in Ottawa in November 1987 to determine the MIACC mandate and terms of reference. The steering committee, which EPC co-chaired in 1988, and several of its working groups, have met regularly since then. The first MIACC annual meeting was held in Ottawa toward the end of November, 1988, attracting 150 delegates from government and the private sector. Fruitful discussions are being translated into action plans for ensuring that the chance of a major incident involving dangerous goods in Canada is absolutely minimized and if, with all the good planning in the world, there were a major incident, at least it could be contained quickly and effectively.

We in Canada subscribe very strongly to the idea that prevention is better than cure, especially as it applies to dangerous goods.

Use of Computer Models and Data Bases At Spill Scenes

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ABSTRACT

Many computer models for predicting chemical behaviour and computerized chemical information data bases are available. The use of these computer systems for spill response is appraised.

Many chemical releases are instantaneous or for practical purposes, nearly so. Given the average wind conditions in Canada of 10 km/hr, any vapour from an instantaneous release has gone as far as 1 km in 6 minutes. These data show that the use of computerized data for decision making directly at the spill scene is not practical. First responders do not have time to consult models or any other non-immediate information source before making evacuation or other first-action decisions. The vapour plume travels at the same rate in case of the slow leak type of spill, but models could be used to predict how long such situations will last. Data banks have the same use limitations at spill scenes and in practice are rarely used in this manner, the preferred information source being spill manuals which can be accessed in a matter of seconds.

The accuracy of spill models is summarized and spill source models are often found to be erroneous. This results in plume concentration prediction errors as large as the input errors. A number of new models have better source estimation procedures and can more accurately predict downwind concentrations. Data bases are also rapidly improving, but often have errors or omissions.

The conclusion is that computerized systems have little application during the first few minutes of spills and are best used for assessments or spill countermeasures planning. The time is simply not available to permit proper use of either a data base or a spill model to decide on evacuation or other critical first actions. Both classes of computer programs still have inaccuracies and shortcomings and it is recommended that more than one source of data be used for critical decisions.

INTRODUCTION

The use of computers for spill control information dates from the early 1970's. Environment Canada, for example, had a computerized incident history data base known as NATES (National Analysis Of Trends in Emergencies System) and another system for locating spill control equipment, NEELS (National Environmental Emergency Equipment Locator System).[1] Both systems were initiated in 1973 and the former system is still operational. The United States Coast Guard has a spill prediction system, HACS (Hazard Assessment Computer System), which has a variety of spill prediction modules for spills on water and into air. This system resides on a main-frame (very recently installed on a mini) at the Coast Guard response centre on Governor's Island. This system has been used since the 1970's to provide information on the predicted concentrations of hazardous material spills.

Air plume dispersion models have been available for many years and are often used to predict where spills might go and what the concentrations might be. All of these systems resided on main frame computers until recent years.

The advent of desk-top and portable computers in the 1980's also heralded the arrival of spill-oriented software as well as software for other applications, but having use in the spill response business. These packages include mathematical spill prediction models which allow for the predication of spill fate and effects as well as data bases for information about chemicals. Many of these packages are now on the market and are difficult for the potential user to evaluate. Some of the packages are over-sold and may not even be applicable to spill situations. The promise of a high technology solution to the spill problem has seduced many an unwary buyer into a purchase which did not fullfil his needs nor the initial promises. The purpose of this paper is to introduce spill responders to computerized packages and their applicability to spill situations. The paper will, hopefully, enable potential users of computerized spill packages to assess what they need and whether the software will indeed benefit them.

TIME TO USE A COMPUTER FOR SPILL RESPONSE

Many computerized systems are now being offered as on-site tools. The concept being promoted is that the first responder would get crucial information on the chemical or even predict how far to evacuate in the event that this was necessary. Some systems even include site plans and the specific data on the quantity and location of hazardous materials at that site. Although such applications sound interesting and useful, the time to actually make decisions at the spill scene may preclude the use of computers, either on or off the site.

Table 1 shows the times that a contaminant plume would move in air at various wind speeds. The table shows that very little time is available to act, especially in the case of zones immediately downwind of a spill site. A first-response organization , usually the fire department, typically arrives on the scene within a few minutes of an incident and has only a few more minutes to make decisions on evacuation. Table 2 shows the typical times to retrieve computerized information or access spill manuals. These times are generally long for computer systems and do not allow for the use of a spill model to estimate downwind evacuation distance. This is especially true in the case where the computer is accessed remotely by telephone.

Similarly, responders in critical situations can not wait long times for basic information about the properties of the substance spilled. The use of computer system is particularly not advantageous compared to the use of spill manuals. There exist many good spill manuals and these can be accessed within a

TABLE 1 TIME BEFORE LEADING EDGE OF PLUME HITS TARGET

WIND SPEED (km/hr)	TIMES TO REACH TARGET (min)					
	DISTANCE TO TARGET (km)					
	1	**2**	**3**	**5**	**10**	**20**
1	60	120	180	300	600	1200
2	30	60	90	150	300	600
5	12	24	36	60	120	240
10	6	12	18	30	60	120
15	4	8	12	20	40	80
20	3	6	9	15	30	60
25	2.4	4.8	7.2	12	24	48
30	2	4	6	10	20	40
40	1.5	3	4.5	7.5	15	30
50	1.2	2.4	3.6	6	12	24

TABLE 2 **TYPICAL INFORMATION RETRIEVAL TIMES**

SYSTEM TYPE	TIME TO PERFORM FUNCTION IN MINUTES				
	SET-UP	CALL-IN	DATA INPUT	COMPUTE/ RETRIEVE	TOTAL
COMPUTERS- AIR DISPERSION MODELS					
typical micro portable system	5		10	10	25
typical micro desk system		5	10	20	35
fast system on response vehicle	2		2	3	7
main frame		5	20	20	45
COMPUTERS - DATA BASES					
typical micro portable	5		1	1	7
typical micro desk system		5	1	1	7
fast system on response vehicle	2		1	1	4
main frame		5	5	10	20
SPILL MANUALS					
search one chemical					0.5
search 3 manuals					1
use nomogram for dispersion					5
use table for dispersion					1

minute. Furthermore, at the current state of technology, spill manuals contain much more information than most data bases and are much cheaper. The current state-of-the-art makes it difficult to replace the book with the computer - at least in the next few years.

COMPUTERIZED DATA BASES

Many computerized data bases currently exist. Examples of some publicly-available ones are given in Table 3. Many other data bases exist but are developed for internal purposes. Most large firms have data bases inventorying their chemicals and also providing occupational health and spill information.

Potential subscribers to the data should first consider the date required for spill response and the data actually offered by the computerized service. Table 4 shows the information required for a typical spill response.

Secondly, the prime purpose of the data base should be considered. Table 3 shows that most available data bases are designed for purposes other than spill response. These can be divided into 4 classes of information; occupational health and safety, spill information, general chemical information and specialized data bases. Most currently-available data bases are intended for occupational health and safety applications and may not contain essential spill response information. Furthermore, they may not contain information on frequently spilled chemicals. They may not be designed for rapid access and retrieval of information and cannot practically be used during the spill incident.

CAMEO is an example of a rapid-access spill data base and also has other features such as spills models, a chemical inventory data base and a site-plan data base. Versions of this system have been installed in computers mounted directly in response vehicles. This is the only known example of a commercially-available system deployed in this manner.

The third consideration for purchasing data bases is that of data accuracy. When many systems appeared on the market in the past few years, most suffered from inaccurate or incomplete data. In one instance, a data base was put on the market with only one handbook used as the data source. The data base also contained many transcription errors. Some systems currently on the market have many data errors. If computerized systems are used for critical response decisions, that data should be checked with other sources. The same rule applies to any source of data, verification should always be made with one or two other independent sources to ensure accuracy.

The final consideration for data base evaluation is that of the quantity of data actually in the base. Its very easy to be mislead by the large number of diskettes in a particular data base. A book can easily contain the equivalent of 0.5 to 1 gigabytes (1 gigabyte = 1000 megabytes) of information. Even with data compression of 5 to 1, 100 to 200 standard floppy diskettes would be required to hold that same amount of information. Most currently-available data bases have considerably less information. Both the number of substances and

TABLE 3 EXAMPLES OF COMPUTERIZED DATA BASES

SUPPLIER OR SOURCE	DATABASE NAME	PRIMARY USE	APPLICABLE TO SPILLS	NUMBER OF SUBSTANCES	COMPUTER SYSTEM
A.D.Little	CPCbase	occupational	some	400	micro
CCOHS	TRADENAMES	workplace	some	100000	micro
	RTECS	workplace	some	1200000	micro
	CHEMINFO	workplace	yes	3000	micro
	TDG	placarding	some	4000	micro
	RIPP	pesticides	some	2000	micro
	16 bibliogrph	occupational	little	2000	micro
CIS	HAZINF	industrial	some	200	main frame
	CHRIS	spills	yes	1000	main frame
	OHMTADS	environmental	yes	1400	main frame
	TSCATS	health	little	?	main frame
	RTECS	workplace	some	1200000	main frame
	MERCK	industrial	some	20000	main frame
	MALLIN	industrial	some	1400	main frame
	SOLUB	general	some	3000	main frame
	GIAB	health	some	3000	main frame
	AQUIRE	environmental	some	2000	main frame
	SUSPECT	regulatory	little	2000	main frame
CSST	toxicdatabase	health	little	1000	main frame
EPA	IRIS	risk analysis	some	1000	main frame
H&W Can	IRPTC	general info	some	600	main frame
Instant	clothing-KF	occupational	some	1000	micro
	INSTANT	occupational	some	300	micro
	GlovES	occupational	some	300	micro
NOAA	CAMEO	spills	yes	600	micro
NUMERICA	SYNDEX	general	some	1000	main frame
	CALSEP	general	some	2000	main or micro
	CHEMEST	general	some	5000	main or micro
	QSAR	environmental	some	5000	main or micro
	fate db	environmental	some	1000	main frame
TDG	CHEMCOM	emergencies	yes	1000	mini
VIS	CHEMTOX	workplace	some	3000	micro

TABLE 4 **DATA REQUIRED FOR SPILL RESPONSE**

CATEGORY	ESSENTIAL DATA	DESIRABLE DATA
FIRE/EXPLOSION	flash point extinquishing agents explosion limits unusual behaviour reactivity	ignition temperature combustion products
HEALTH DATA	IDLH TLV other toxicities toxicity of combustion products toxicity of degradation products respiratory protection odour threshold	
IDENTIFICATION	numbers names overall primary hazard appearance	manufacturers
PHYSICAL PROPERTIES	boiling point melting point solubility in water	vapour pressure solubilities
ENVIRONMENTAL DATA		aquatic toxicity bioaccumulation food concentration potential mammalian toxicity biodegradation
COUNTERMEASURES	compatible clothing cleanup procedures evacuation requirements	sorbents treatment measures

the amount of information on each substance should be considered. Ease of use, output form and presentation should also be considered. Any potential buyer or subscriber is advised to get a demonstration or a demonstration version before buying the system. This demonstration should be run without the aid of a salesman to allow for an independent check-out of the system. Many suppliers, even those of main frame systems, have demonstration versions.

SPILL PREDICTION MODELS

Spill prediction models are not as easy to understand or use as are data bases. Because of this, extra caution must be exercised in selecting such systems. Many spill models exist. Virtually every researcher in the field has produced a computerized spill model. One paper published a few years ago listed 51 oil spill movement prediction models alone.[2] If one were to count all of the models designed to yield a spill prediction of some type, the number would no doubt, be in the hundreds. Most models do not survive with time and most have never been commercialized. Table 5 lists some chemical behaviour prediction models that are available commercially or publicly.

There are three basic types of chemical behaviour and fate models of relevance to spill response:

1. Models that predict the transport of chemicals through the environment and give concentration levels as a function of time.
2. Models that predict the final deposition of chemicals in compartments - eg. in air, water, soil, or sediments.
3. Models that predict the effects of chemicals on elements of the environment - for example, there exist models to predict the effect of oil spills on cod stocks.

Combination models of the above also exist.

The models used most frequently for spill response are those of group one- those that predict the movement of chemical through the environment and the concentration at a particular time and location. An example of this type of model is the popular air dispersion models used to predict the down wind concentration of gas releases.

Models can be first divided on the basis of which media they pertain to; air, water, soil, sediment or combinations of these. Additionally, models may be created for general geographic use or are created for use in a specific geographic location. For example, a number of specific models have been created to predict pollutant transport on or in a given river system. Application to another river system would require extensive modification. A St. Lawrence oil spill model and a chemical spill model for the Upper Fraser River have been developed, as examples.[3,4]

A most useful technique for assessing models is to tabulate the inputs and outputs each model provides. If a model does not allow for the input of a critical variable - it does not use it in its design or defaults to a generic value. Outputs may not be what is desired or in the most useful form. The list of inputs and outputs will also give one an idea of how the model works and

TABLE 5 EXAMPLES OF SPILL PREDICTION MODELS

SUPPLIER OR SOURCE	MODEL NAME	PRIMARY FUNCTION	AVAILABLE TO PUBLIC	APPLICABLE TO SPILLS	COMPUTER SYSTEM
AES	AQPAC	gas release	results	yes	micro
	in house	gas release	results	yes	main frame
Concord	COBRA	gas release	commercial	yes	micro
Davis Eng.	DERAC	derailment	commercial	yes	micro
E&E	EPIDIS	leak and spill	commercial	yes	micro
ERT	HASTE	gas release	commercial	yes	micro
EETD	LEAKR	spill rate	yes	yes	micro
	spreading	liquid spread	yes	yes	micro
Envirosoft	RSPILL	river spills	commercial	yes	micro
Envirosphere	TOXCHM	gas release	commercial	yes	micro
EPA	PUFF	gas release	commercial	yes	micro
	INPUFF	gas release	commercial	yes	micro
LLNL	SLAB	gas release	results	yes	main frame
	ARAC	gas release	results	yes	main frame
NOAA	CAMEO	gas release	commercial	yes	micro
Ontario Gov't	TOXIC	gas release	yes	yes	micro
	in house	gas release	results	yes	mini
PLG	MIDAS	gas release	commercial	yes	micro
Radian	CHARM	gas release	commercial	yes	micro
SES	SAFER	gas release	commercial	yes	micro
Senes	AERIS	decommissioning	commercial	little	mini
Trinity	BREEZE	gas release	commercial	yes	micro
	TRPUF	gas release	commercial	yes	micro
	SPILLS	gas release	commercial	yes	micro
	SHELL SPILLS	gas release	commercial	yes	micro
TMS	SAFEMODE	gas release	commercial	yes	micro
USCG	HACS	most spills	results	yes	mini

what it does with data. The latter is most important since some models may not perform all necessary calculations. As an example of this, an assessment of a recently-developed river model showed that there was no component to model the behaviour of the pollutant as to whether it sank, mixed or floated. The model simply presumed complete mixing within a given length of river channel and moved this completely-mixed slug down river. Such simplification would be completely unsatisfactory for a chemical that did not mix with the water.

Guidelines exist for the evaluation of environmental fate models.[5] The ASTM guideline lists items that should be included and a number of evaluation points.

The most commonly used models for spill response are those that predict air dispersion. Of these there exist two fundamental types; trace air models and spill or mass release models. Trace models are applicable to the modelling of trace amount of gas in air, for example stack gases or continual releases. Trace models do not yield accurate results when applied to most spill situations. Spill models (sometimes also called heavy gas dispersion models) simulate the flow-like characteristics of a very large gas release.[6] Trace gases do not behave in the same manner, they mix slowly with the ambient air. Heavy gas spills differ also in their behaviour by damping turbulence in the vicinity of the flow - a factor that causes less mixing and also by forming relatively stable stratification levels where lighter and relatively-contaminant-free air can ride on the dense heavy gas.

Models should be examined to ensure that they include several critical components - especially how they handle input of the amount of chemical to be transported. Models should be supplied with or used with input models that include realistic pool spreading and evaporation models. Recent analysis of models showed that several are deficient in this aspect and that ignoring spreading and evaporation behaviour can result in severe prediction errors.[7] Errors in input data are propagated through the model and in some cases can even be magnified. Models should also be responsive to different atmospheric conditions including stabilities and mixing layer heights.

There are two basic types of mathematical air dispersion models; the Gaussian and the Box.[8,9] Gaussian models have been around for many years and are based on measured parameters at different atmospheric stabilities. Atmospheric stabilities are defined from A to F. F is very stable and under this condition, little turbulence and consequently mixing, takes place. Stability D is very typical of day time conditions with a moderate wind blowing. Gaussian models were originally designed for trace air models but with modification, are able to provide reasonably-accurate spill predictions. Gaussian models will often over-predict concentrations in the zone near the spill, but under-predict concentrations farther downwind. Efforts to compensate for this deficiency have also been undertaken.

Box models presume that the chemical flows somewhat like a liquid and mixes only very slowly with the surrounding air. This physical model is, in fact, more accurate than that presumed in the Gaussian case. Box models are designed for the near field or that zone very close to the spill release. They assume that a number of physical parameters are conserved at every point in time after the release of the chemical. Simultaneous equations are solved to conserve mass, energy and momentum at each time increment. Two types of Box models exist; those known as "intermediate models" and those known as "3D time dependent". The latter are more accurate and involve the solution of more equations.

Box models are not relevant to long distance transport. Combinations of Box and Gaussian models can also be used to give even more accurate solutions than either model alone and provide accurate predictions in the near and far field.

Models for predicting the movement of chemicals in water are not common, whereas models for predicting the movement of spilled oil and similar substances on water are common.[10] The latter are constructed by combining complex hydrodynamic models and spill spreading models. There is little fundamental difference between existing models. Similarly for models that predict the behaviour of soluble or partially soluble materials in water, there is little fundamental difference between existing models. All employ some form of hydrodynamic model to predict movement and a diffusion model to move and distribute the chemical throughout the water column. A variation on this theme are the models used to predict the behaviour of insoluble sinking chemicals. Models have been constructed to predict the movement of these along the bottoms of rivers. Models usually also predict the slow dissolution of the chemical in the water.

Models for predicting the movement of chemical into soil have found recent popularity, particular with the recent concern over groundwater quality.[11] Modelling of chemicals in soil is difficult because of the following:

1. soil actually has four significant sub-compartments:
    a) soil air,
    b) soil water,
    c) soil solid, and
    d) free groundwater,
2. soil is usually very inhomogeneous,
3. chemical movement through soil can vary widely due to the presence of cracks, channels, roots and animal burrows, and,
4. carbon and mineral content, which have strong influence on behaviour, are hard to predict in various soils.

It is very important with spill models to assess output with typical cases of input data. Models are only useful if they predict outcome with a certain amount of reality.

RECOMMENDATIONS

Spill responders should evaluate computerized systems carefully before purchasing or subscribing to them. There are many drawbacks to using computer systems for direct access at spill scenes, the most important being the time to use any form of computer system. The state-of-the-art in such systems is still rapidly changing. There is currently only one integrated data base and spill modelling system intended for application in response vehicles. This is the CAMEO system.

Most commercially or publicly-available data systems currently on the market do not contain all the information necessary for spill responders. Spill responders are advised to continue using spill manuals alone or in addition to any computerized data bases.

Spill prediction models are complex to understand and use. Potential purchasers are advised to consult spill modelling experts before purchasing and also consult other users of such models. Models should also be evaluated against the criteria presented in this paper.

Finally, consideration should be given to computer compatibility of any intended purchase. It would be wise to have a company representative install the system on your computer before purchase is complete to ensure that it will actually run on your system. Some models or systems currently available require special computer equipment. Systems that run on the widely-available IBM-compatible machines are suggested. Special computers should not be purchased to run some piece of software.

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The Use of Computers in Spill Response

by

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Abstract

This paper describes the use of small battery powered lap-top computers during the response to an incident. Various functions can be made more convenient using an on-site computer. The requirement for communication with mainframe computers and head office can be reduced by using an on-site system. This will relieve the load on communication circuits, which is especially critical in remote locations.

Introduction

During the past decade, there have been great advances in the application of computers and computer technology in most phases of our lives. Computer systems are used in many consumer products as process or sequence controllers. These hidden computers are very powerful, flexible and reliable. The most visible manifestation of the application of computer technology is the advent of the personal computer, and its smaller cousin, the lap-top computer. These small economical systems have computational powers greater than the mainframe machines of a decade ago, and have truly brought computing into every office. In emergency response, the advent of the small lap-top battery powered computer has meant that a high level of computer power is now available at the site of an incident. There are however some limitations to the capability of these systems.

Portable battery-powered computers provide the availability of a large amount of computer power in the field at the location of an incident. How can this be used to improve the response to an incident?

There are several areas in which an on-site computer has applications, such as:

1. Running of various trajectory models

2. Communicating with the mainframe system

3. Providing a locally available database

4. Making available a graphic information system

5. Accounting

6. Supplying a spill management system on-site

7. Furnishing training in response methods and simulations of incidents

Models

There are a number of applications of computers to supply needed information for those responding to a spill situation. An essential piece of information during a spill response is a knowledge of the location of the spilled product and a prediction of the future motion of the contaminants. There is a need not only to predict the motion of the material, but also to predict the concentration and modification of the plume due to various weathering processes. There are many models of various degrees of complexity that have been developed for this purpose. These models can be divided into those dealing with lighter-than-air gas, heavier-than-air gas, buoyant non-miscible liquids on water and spills on soil. Each of these situations requires a different model type and different input parameters. Most of the models now in general use have been developed to run on a large mainframe computer and have been adapted to small computers as their computational power has increased. This translation process has generally involved modifications in coding, a simplification of the algorithms and a reduction in the number of input parameters.

The computational ability of present day lap-top computers is limited and this affects the choice of models to be run. If the calculation time is longer than a few minutes, the results are probably too late, and not useful. Many of the more complex models, designed for large mainframe machines, take from tens of minutes to hours to produce results on a lap-top. This is generally not acceptable.

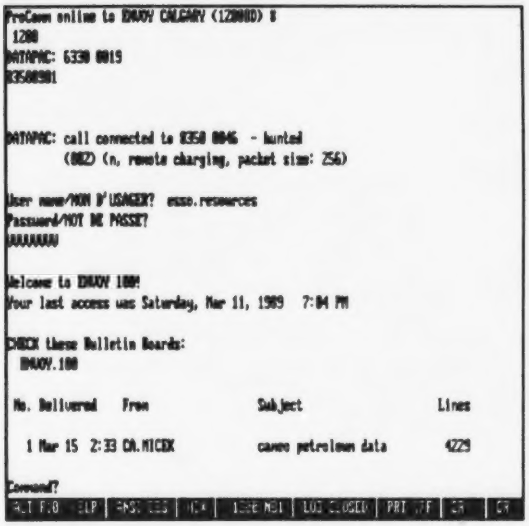
The model must be easy to use and the required input data must be readily available in the field if the model is to be useful. This implies that the characteristics of the chemicals must be available as a data base, the meteorological data should be simple in format and detail, and a wide choice of units for input should be acceptable. Similarly, the output should be easy to interpret, and of limited volume. The most suitable is a graphical form, preferably superimposed on a map of the area. The contours should be in terms of useable units (such as TLV, STEL and IDLH) for the material involved, not concentration in ppm, although this could be available as an option.

Communication

Communication and documentation is an integral part of any emergency response activity. The availability of a lap-top computer on site can be used in many ways to assist in these functions. The most obvious is the use of the computer as a word-processor to prepare reports, to document activities and to provide press releases and similar materials. These activities imply the availability of a printer on site. There are a number of battery powered dot-matrix printers which can be used for this purpose.

The computer can be used as a terminal to the head-office computer and its internal electronic mail system, and to public electronic mail systems such as Envoy 100 and Infonet as shown in figure 1. This of course implies the availability of a reliable telephone link and a modem on the computer.

Using electronic mail systems rather than telephone communication has numerous advantages. Reports can be sent to a number of recipients at the same time, are in hard copy, are time dated and the material can be forwarded at a time convenient to the response group. This is particularly important in a country the size of Canada which extends over seven time zones.



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ProComm online to ENVOY CALGARY (1200BD) 8
 1200
DATAPAC: 6330 0019
8350 0301


DATAPAC: call connected to 8350 0046  - hunted
        (002) (n, remote charging, packet size: 256)

User name/NOM D'USAGER?  esso.resources
Password/MOT DE PASSE?
UUUUUUUU

Welcome to ENVOY 100!
Your last access was Saturday, Mar 11, 1989   7:04 PM

CHECK these Bulletin Boards:
  ENVOY.100

 No. Delivered    From                    Subject                 Lines

  1 Mar 15  2:33 CA.MICEX                canmo petroleum data      4229

Command?
```

Figure 1 Electronic Mail System

The computer can be used to access data bases on the characteristics of the chemicals (ie. properties and toxicities) involved in the incident . Such material may be available on a company data base, or on a number of national and international databases maintained by government agencies. In addition to interrogating these databases, the computer can be used to access meteorological forecast systems. These systems provide both real-time and forecast wind, temperature and cloud cover information which is needed for input into the trajectory models. Weather forecast information is a central component in the strategic planning of the response.

Databases

In many incidents in remote areas, there is limited or no access to a reliable communications system of sufficiently high quality to enable the establishment of reliable digital- data link. In this case, the on-site lap-top computer can be used to provide the basic information required to undertake the response. This data base could include a number of functions designed to assist the on-scene commander in responding to an emergency. These would include response decision trees, equipment and manpower availability, contact lists and telephone numbers, environmental sensitivity maps and simple calculation aids. These should be available in a simple to use, menu-driven system. The output should be simple to understand and should filter out extraneous information. An editing system is required to enable the data base to be maintained.

The output of any computations and the environmental sensitivity maps should be graphic in nature.

Graphic Information Systems

While a simple data base system can provide useful information in the undertaking of a response function, a more complex Graphic Information System (GIS) can provide details of the area, and response information in a readily understandable form. A functional GIS system can be used to generate maps of an area as required, and then provide overlays giving information specific to the incident response.

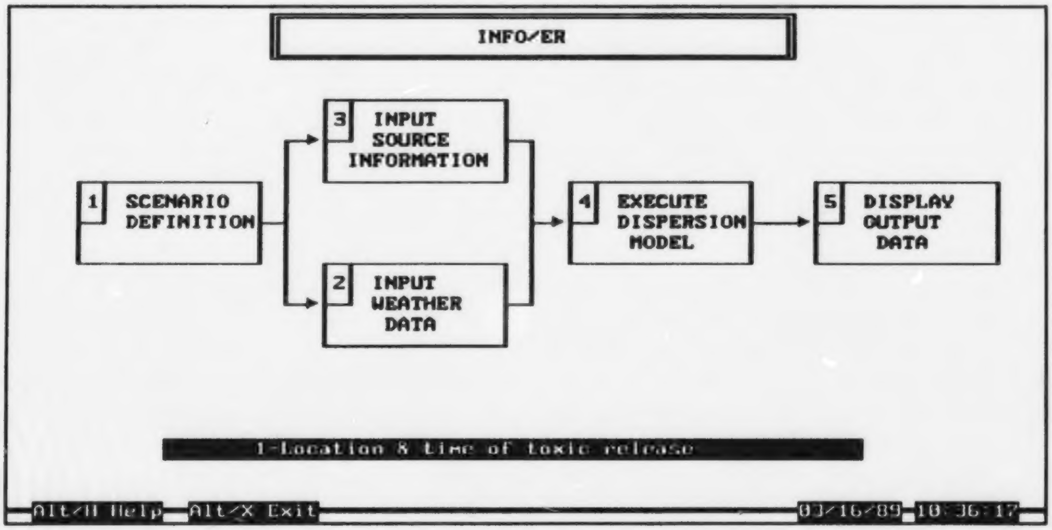
Accounting

The computer can be used to provide simple accounting functions, and maintain control over the cost of the response. While this can be done in other ways, the use of the computer will reduce the number of errors and provide prompt information concerning the cost of the spill.

Spill Management Systems

The computer can be used to allow the on-scene commander to explore the impacts of various possible response functions, and select those which are most effective. In order to undertake such simulations in real time, suitable models must be available, whose output can be readily understood.

Rather than have a number of distinct functions as described above, it is better to have a computer management system which allows access to meteorological parameters and the contents of databases from a single unified shell. This allows the on-scene commander to use the computer in an optimal manner. In order to illustrate these ideas, an existing program will be used as an example.

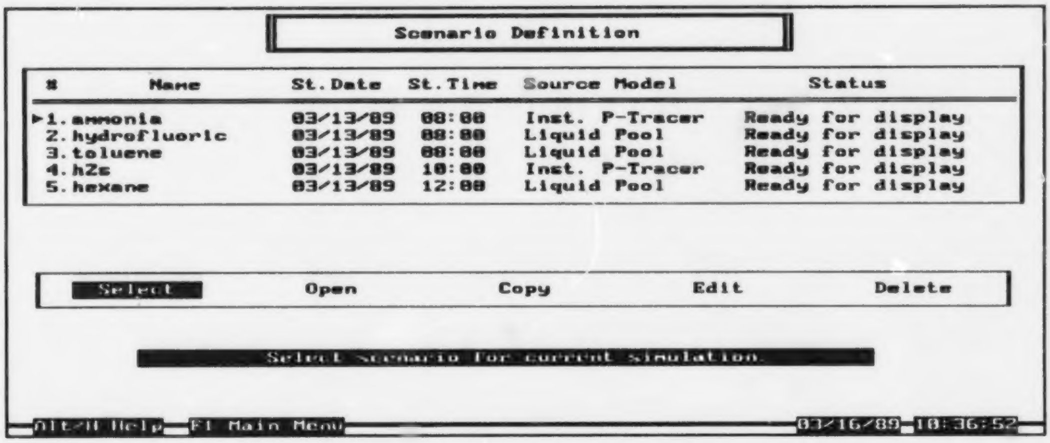


1-Location & time of toxic release

Figure 2 Flow Diagram for INFO/ER

The first is a model used to compute the dispersion of a gas from a chemical release. The program is called INFO/ER, an acronym for INFOrmation in Emergency Response. The first screen, as shown in figure 2, shows a simplified flow diagram of the program. All elements required to describe the situation must be entered before the model (4) will execute.

First the scenario must be defined and described. This process is started by pressing 1, which generates the screen shown in figure 3. This shows some of the chemicals that have been pre-selected and are ready for trajectory calculations as indicated by the status. This selection can be changed using the editing keys. Note that this is an identification only, and does not define the scenario.



```
                          Scenario Definition

 #      Name          St.Date   St.Time  Source Model          Status

▶1.ammonia           03/13/89  08:00   Inst. P-Tracer   Ready for display
 2.hydrofluoric      03/13/89  08:00   Liquid Pool      Ready for display
 3.toluene           03/13/89  08:00   Liquid Pool      Ready for display
 4.h2s               03/13/89  10:00   Inst. P-Tracer   Ready for display
 5.hexane            03/13/89  12:00   Liquid Pool      Ready for display

   Select          Open          Copy          Edit          Delete

               Select scenario for current simulation.

Alt-H Help  F1 Main Menu                              03/16/89 10:36:52
```

Figure 3 Pre-configured scenario list

Pressing the 2 key shows the weather information, as shown in figure 4. The meteorological data for the next five hours has been entered . This information has been obtained from the local forecasting office. As you can see the weather will warm up, the wind change from northwesterly to northerly and the sky will clear. In terms of response, the atmosphere is becoming more stable, but the wind shift should be watched since the plume will move to a previously untouched location by noon. This meteorological data can be updated as required. Previous data scrolls to the left, and new data can be entered.

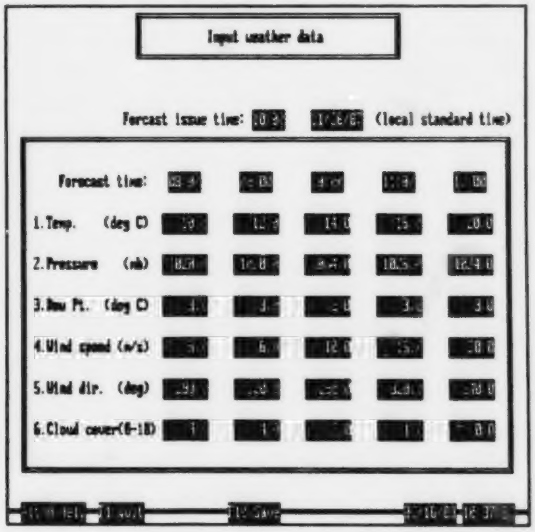

Input weather data
Forcast issue time:
(local standard time)
Forecast time:
1.Temp. (deg C)
2.Pressure (mb)
3.Dew Pt. (deg C)
4.Wind speed (m/s)
5.Wind dir. (deg)
6.Cloud cover(0-10)
F10 Save

Figure 4 Weather Data Matrix

Pressing F10 stores this data, and returns to the flow diagram. Pressing key 3 brings the screen shown in figure 5. This screen allows the description of the incident. Pressing F2 allows a selection of the chemical from a list of 90 chemicals currently included in the data base as shown in figure 6.

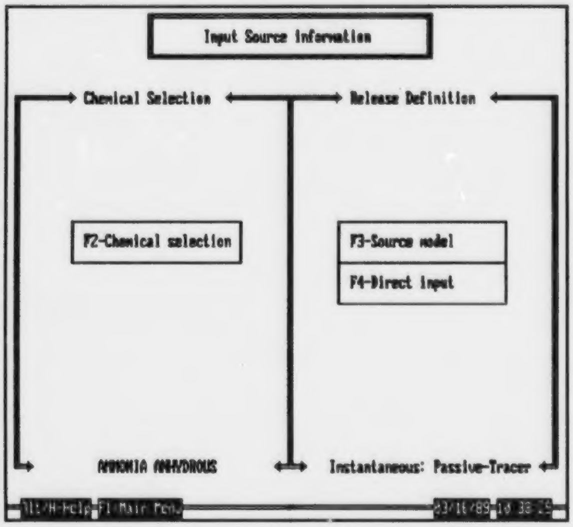
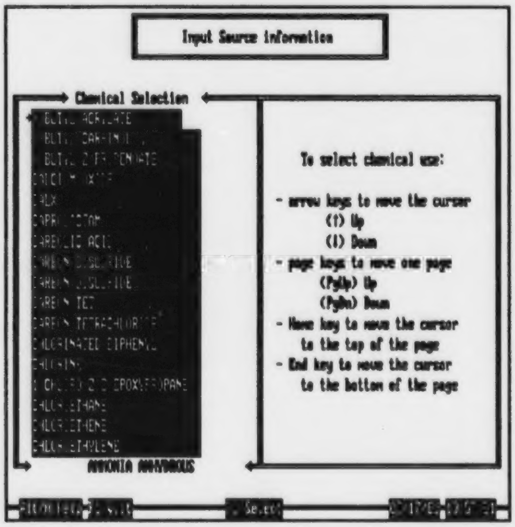

Input Source Information
Chemical Selection
Release Definition
F2-Chemical selection
F3-Source model
F4-Direct input
AMMONIA ANHYDROUS
Instantaneous: Passive-Tracer

Figure 5 Selection of Input Description


Input Source Information
Chemical Selection
AMMONIA ANHYDROUS

To select chemical use:

- arrow keys to move the cursor
  (↑) Up
  (↓) Down
- page keys to move one page
  (PgUp) Up
  (PgDn) Down
- Home key to move the cursor to the top of the page
- End key to move the cursor to the bottom of the page

Figure 6 Chemical Selection Menu

Once the chemical has been chosen, the nature of the release must be defined by pressing F3. When the tank description is selected by pressing enter, the screen shown in figure 7 is displayed.

The nature of the container can be defined, the dimensions entered as shown in figure 8. Next, the nature of the rupture must be described. The highlight is moved to the rupture selection, and enter is pressed.

This displays the screen shown in figure 9, and the appropriate pattern is selected, and then the screen displays figure 10.

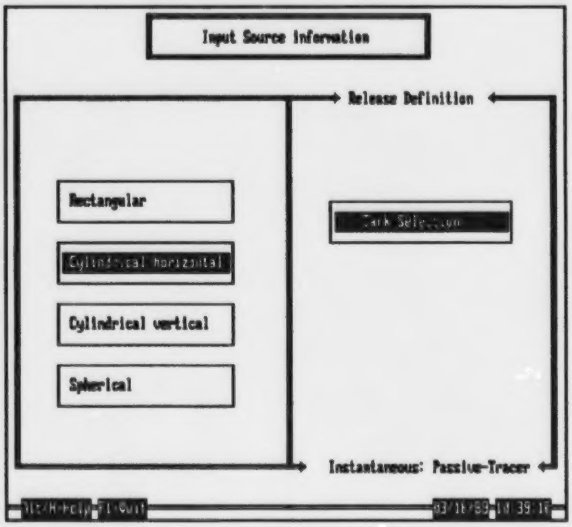
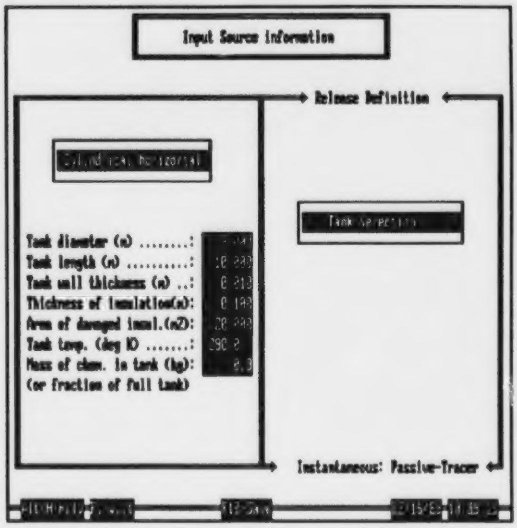

Input Source information
Release Definition
Rectangular
Cylindrical horizontal
Cylindrical vertical
Spherical
Tank Selection
Instantaneous: Passive-Tracer
Alt/H=Help F1=Quit

Figure 7 Selection of Tank Shape


Input Source information
Release Definition
Cylindrical horizontal
Tank Selection
Instantaneous: Passive-Tracer

Tank diameter (m) ....: [illegible]
Tank length (m) ....: 10.000
Tank wall thickness (m) ..: 0.010
Thickness of insulation(m): 0.100
Area of damaged insul.(m2): 20.000
Tank temp. (deg K) ....: 290.0
Mass of chem. in tank (kg): 0.0
(or fraction of full tank)

Figure 8 Selection of Tank Size

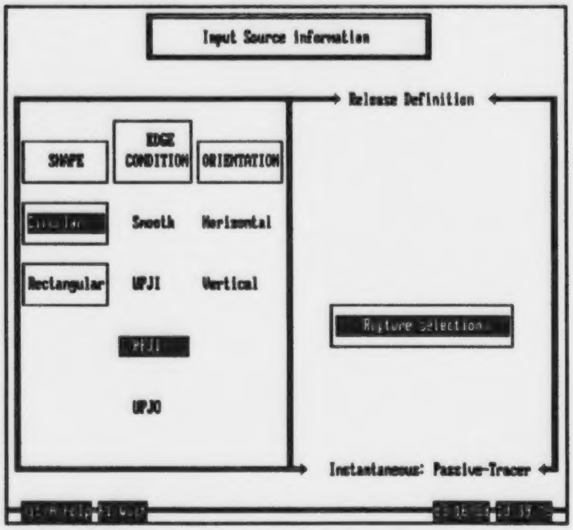
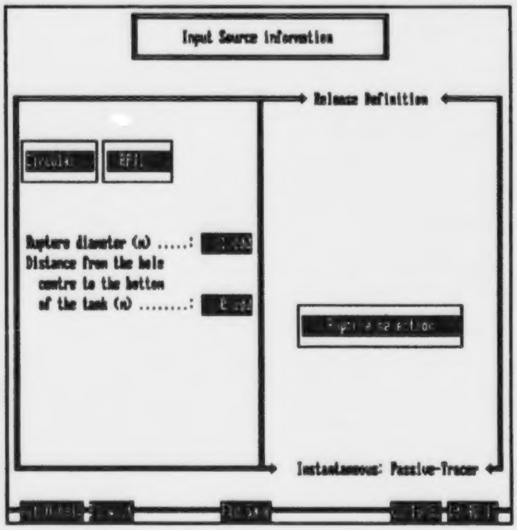
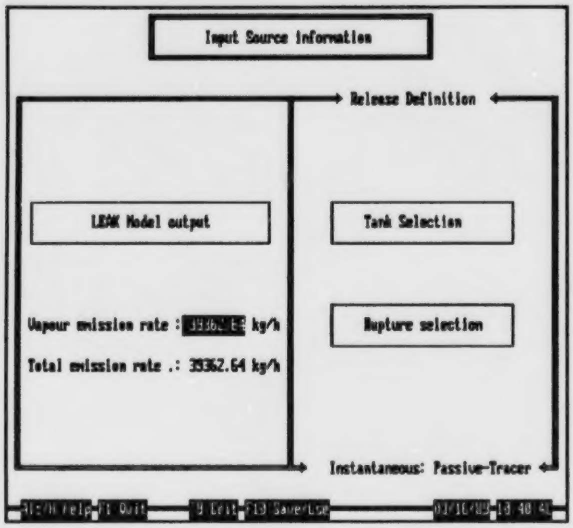

Input Source information
Release Definition
SHAPE
EDGE CONDITION
ORIENTATION
Circular
Smooth
Horizontal
Rectangular
UPJI
Vertical
RFJI
UPJO
Rupture Selection
Instantaneous: Passive-Tracer
Alt/H=Help F1=Quit

Figure 9 Description of Hole Shape


Input Source information
Release Definition
Circular
RFJI
Rupture selection
Instantaneous: Passive-Tracer

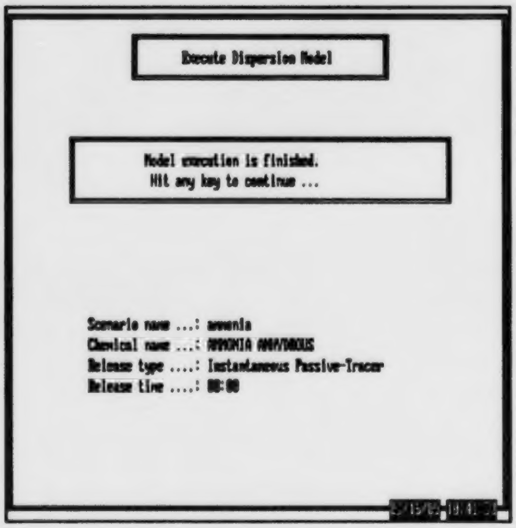
Rupture diameter (m) .....: [illegible]
Distance from the hole
  centre to the bottom
  of the tank (m) ....: [illegible]

Figure 10 Input Size of Hole



```
Vapour emission rate : 33362.64 kg/h
Total emission rate .: 33362.64 kg/h
```

Figure 11 Results of Leak Model



```
Model execution is finished.
 Hit any key to continue ...

Scenario name ...: ammonia
Chemical name ...: AMMONIA ANHYDROUS
Release type ....: Instantaneous Passive-Tracer
Release time ....: 00:00
```

Figure 12 Dispersion Model Operation

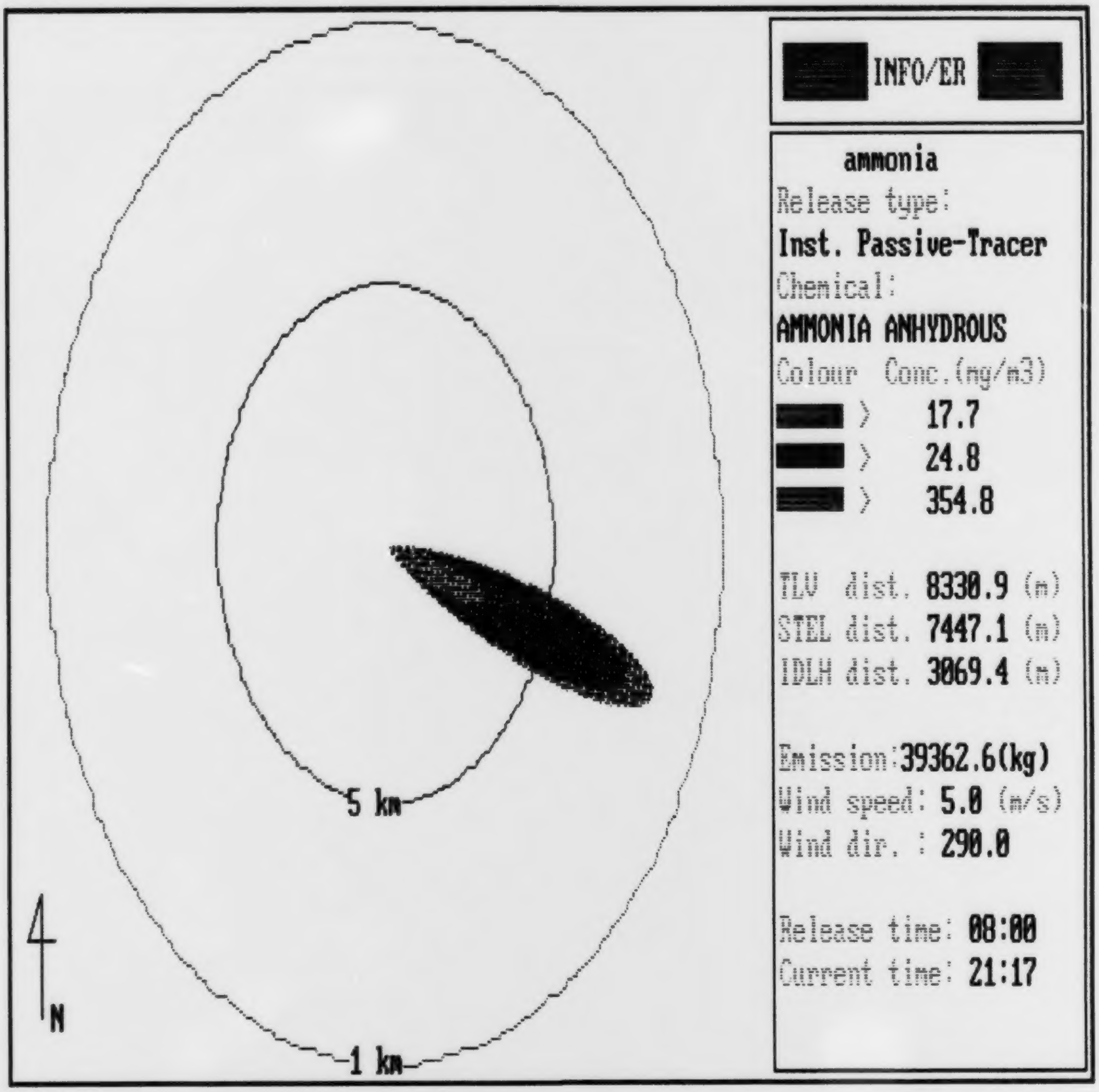
Once the values have been selected, a leak rate model calculates the emission rate which is shown in figure 11. If this rate is known to be incorrect, it can be changed using the edit key F9. At this point, both the environmental conditions and the nature of the emission have been defined, and the dispersion model can be executed by returning to the flow diagram using F1, and then pressing 4. When the model has finished, the screen shown in figure 12 is displayed. In order to see the results of the calculation, press enter and then 5 to display the results as shown in figure 13.

This is an example of a user friendly, integrated gas dispersion program. The model used, in step 4, can be easily changed as improved models become available. INFO/ER is a data handling and management shell. The computer programs used for the present system have been developed by a number of authors and are available from Environment Canada. Any program can be used for the calculation of the dispersion with data taken from the shell. This illustrates the flexibility of the system.

Changes in any condition can be quickly entered, and a new computation run. This process takes less time than was required to describe the process. A typical run takes about two minutes to complete.

Computational Capabilities

The computer can be used to calculate simple equations which are frequently needed during a spill response. There are numerous examples of such calculations, such as the amount of foam needed to cover a certain area, or the volume left in a tank after a known interval.



INFO/ER

ammonia

Release type:

Inst. Passive-Tracer

Chemical:

AMMONIA ANHYDROUS

Colour Conc.(mg/m3)

■ > 17.7

■ > 24.8

■ > 354.8

TLV dist. 8330.9 (m)

STEL dist. 7447.1 (m)

IDLH dist. 3069.4 (m)

Emission:39362.6(kg)

Wind speed: 5.0 (m/s)

Wind dir. : 290.0

Release time: 08:00

Current time: 21:17

Figure 13 Output of Model

Training and Simulations

It is a well established fact that the training of response staff and preparation of equipment are a major component of a successful response to a spill. Since there are very few incidents during which experience can be obtained, it is difficult to provide actual practice in response functions. This void can be filled by using computer simulation models patterned after the war games of the military.

Summary

Computers, on site, can be used very effectively during an emergency situation. In order for these units to be effective, good software must be available and those using the computer must have had some training in its operation. This capability must be backed up by larger computers operated by skilled personnel at the head office or central response centre.

Acknowledgements

The author wishes to thank Esso Resources Canada Limited for permission to present this material. The assistance of Mr. A. Holoboff in the computational aspects of this report is appreciated. Dr. D. McGillivray and his associates of the MEP company in Toronto were responsible for the development of the INFO/ER model.

USE OF COMPUTER MODELS FOR HAZARD/RISK ANALYSIS AND EMERGENCY PLANNING

R. V. PORTELLI AND DR. E. ALP

CONCORD SCIENTIFIC CORPORATION
TORONTO, ONTARIO

DUE TO A CHANGE IN PROGRAM, THIS PRESENTATION WAS ARRANGED AT THE TIME OF GOING TO PRESS. WE REGRET THAT, DUE TO NO FAULT OF THE AUTHORS, THE PAPER WAS NOT AVAILABLE AT THE TIME OF PRINTING

STATE-OF-THE-ART EMERGENCY INFORMATION MANAGEMENT AND COMMUNICATION AT CHEMTREC

Claudette M. Cofta

CHEMICAL MANUFACTURERS ASSOCIATION

ABSTRACT

CHEMTREC has pledged to provide immediate, basic information about chemical products to our hotline callers. This is a tremendous challenge, as more than 600,000 chemical products are commercially produced in the United States.

In order to carry out this task, CHEMTREC has instituted a state-of-the-art digital imaging system to manage and retrieve our chemical information. This system stores a digital "snapshot" of all chemical information submitted to the hotline. The images are then permanently written by a laser into 12" optical disks. When a chemical record is requested by a hotline communicator, the image-document is automatically retrieved and displayed on the terminal within seconds.

The image data has been packaged in the Group III faxing format. CHEMTREC is now preparing to begin faxing these records directly to responders at the scene of a chemical incident.

The management of chemical information for emergency use is an especially difficult challenge. Not only is the sheer volume of information that must be stored overwhelming, but that information is frequently modified and updated. Furthermore, not only is it critical to keep this tremendous library of information up-to-date, but the management system must also be able to rapidly retrieve any of these records upon demand. Finally, the system must be user-friendly, so that the CHEMTREC communicators are not distracted from handling the chemical emergency.

These are tremendous constraints to impose upon a system. There are many systems that are capable of performing a few of these tasks, but in my experience only one that satisfies all of the requirements. Today I will tell you about CHEMTREC image management system, and how it addresses all of the concerns I have listed above.

I will begin with a very general description of the system and technology. Although it strongly resembles a computer in many ways, the image management system has the following important differences. First of all, the data it stores are images or pictures, as opposed to characters such as letters or numbers that would be keyed into a computer. The method of entering data is also very different. Rather than enter the information through a keyboard, it is scanned, or electronically photographed, though a table-top device that closely resembles a fax machine, and indeed produces the image in exactly the same manner.

The information is stored differently, too. Rather than writing on the magnetic disks used by computers, the images are written by a high-powered laser onto an optical disk. Because the laser light actually burns pits into the surface of the platter, the write is permanent. This is good and bad. On the one hand, the media is literally burned up as more data is stored. On the other hand, there is no need to worry about data being accidentally erased, or destroyed by a head crash.

Finally, when records are retrieved, they are dispatched to the terminal as a series of images that represent several documents, or perhaps multiple pages of a single document. A high-resolution terminal is required to view these images.

Now I would like to examine how image management satisfies the extreme demands of the hotline environment.

First, let's address the massive size of the chemical library, and the problems associated with entering the information into it.

As I'm sure most of you know, the only available information for commercial, trade-name products is the Material Safety Data Sheet, or MSDS. In the United States, while there is a requirement for a minimum amount of information that must be on the document, there is no standard format. Therefore, MSDSs from different manufacturers range from two to fifteen pages even for the same chemical, may make liberal use of graphics, and could be styled as a text document, form document, or some combination of the two.

This lack of standardization makes it impossible to key-enter the information into computer system. Graphics, which often convey important information, would have to be dropped out. Form documents could not be reproduced without significant modifications. All of these alternations transfer tremendous liability for the record quality and content to the organization maintaining the library.

Finally, legal and quality issues aside, the sheer number of records would require an army of data entry operators to load this information into the computer. Compounding this problem is the volatile nature of the MSDS. Many of our manufacturers update their MSDSs several times a year. These updates must be entered into the MSDS library in a timely fashion. Therefore, the size and activity of this library makes any attempt to computerize it, at least in the United States, a very impracticable approach.

However, the technique of imaging circumvents both the legal and the loading problems quite nicely. Because we are storing an exact replica of the original record, the lack of a standardized format for the MSDS does not affect us. The image perfectly preserves all of the graphics and other unique features of the document.

The process of scanning, or making the electronic image, can run at a top rate of 24 pages per minute. The net result is that we can load the same information more than 25 times as fast as a computer system. The cradle-to-grave processing time for an average four page document ranges from one to two minutes.

That solves the problem of loading a large volume of information, but it is even more important that the CHEMTREC communicators be able to retrieve any of these records within seconds of receiving an emergency call.

As I mentioned earlier, the MSDS images are written onto optical disks. These disks, which can store an average of 3.2 gigabytes, or 10,000 MSDSs each, are stored in a large cabinet known as a jukebox. Upon receiving a request for a particular MSDS, a robotic arm automatically grabs the appropriate optical disk and places it into a drive. The image is then read by a low-powered laser, and transmitted to the terminal that issued the request. This process takes an average of 12 to 15 seconds to complete. Furthermore, the retrieval time will remain independent of the size of the chemical library. We could conceivably double or triple our information base without compromising the time it takes to provide information to our callers.

Finally, the system is extremely user-friendly. It takes great advantage of the windowing format that MacIntosh or Microsoft users are familiar with. Each window displays an image of an MSDS, a CHEMTREC chemical report, or a list of emergency contacts for a company. The communicator requests this information through a separate window, in which a field for the product name, and/or the manufacturer must be keyed in. The communicator then presses a key to give a search command, and the 300,000 records currently on-line are searched. In cases where there are many records in the library for a given substance, the communicator can choose from an index list for the record of choice,. In this way, with minimal keyed input required from the communicator, and the use of windowing and other visual aids, the retrieval of information is an extremely simple process.

The use of imaging has also opened the door to a new way of communicating this information to emergency responders. Throughout its history, CHEMTREC has provided information primarily by reading it over the phone. While fast, this process has the potential for misunderstanding and misinterpretation. Furthermore, following the conversation with CHEMTREC the firefighters had to rely on their recollection and notes through the rest of the incident.

Now, however, CHEMTREC is preparing to fax the MSDSs directly to responders in the field from the image system. Upon receiving an emergency call, the communicator will still counsel the caller, retrieve the information, and contact the manufacturers. However, instead of reading the information, the communicator will press a "fax" command key, enter the phone number of the receiving fax, and the record will be automatically transmitted from the image system to remote site. Firefighters that are equipped with a cellular phone and portable fax can receive the MSDS on the scene. Otherwise, the MSDS can be faxed to the station house.

I feel that the ability to provide hard-copy will be a tremendous advance in the rapid, accurate communication of emergency information. I thank you for your attention, and hope to see you at your next conference when I can report on the success of the automated faxing system. Thank you.

DECONTAMINATION FOR FIREFIGHTERS

Ed Bowdridge-District Chief

Halifax Fire Department

INTRODUCTION

Hazardous substances can have acute and chronic effects on health, and also may damage equipment. Because of this, emergency response units must develop and prepare for decontamination operations. Also, when a dangerous goods emergency occurs, decontamination must become an integral part of the actions taken to control the incident.

Decontamination is the process of making personnel, equipment and supplies safe after an exposure, by eliminating poisonous, corrosive or otherwise harmful substances. It is one of the most important steps in ensuring personal safety at a hazardous materials emergency, yet few fire departments devote proper attention to the subject. Consequently, we have experienced injuries and confusion during emergency operations.

Technical assistance is available through Canutec and industry. The thing to remember is- (who knows more about the product involved than the manufacturer). More specific details are available than the response guides may provide.

A proper approach to a Dangerous Goods Incident can only be planned for when the product is identified. Showers, scrubbing stations, run-off containment, proper disposal containers and personal protective equipment should be in place before entering a contaminated zone. Decontamination should be carried out according to the degree of exposure as well as material involved.

The need to decontaminate is seen as a means to protect personnel, prevent spread and protect equipment.

This article outlines a complete decontamination process that users can implement with minimum cost. Its success depends on how seriously an organization perceives the decontamination problem to be and on the ability of the incident commander to control personnel at the emergency. The information is intended to be used as a guideline for preparing individual operating procedures. These guidelines necessarily are flexible.

The complexity of decontamination operations required at an incident depends on the safety and health hazards of the contaminants, An uncontaminated light oil that presents a minimal hazard, for example, can be partially decontaminated by flushing it from protective clothing. In contrast, a corrosive or poisonous material will require a careful, detailed course of action. Several intermediate cleaning steps may be necessary before the contaminated person is clean enough to leave the decontamination area safely.

Methods of Decontamination

The acceptable methods of personnel decontamination include three techniques: dilution, absorption and chemical degradation. For contaminated equipment and supplies, there is a fourth option: disposal and isolation. No designated priority exists for these methods because the hazardous materials involved and availability of decontamination resources will vary. There is however, a logical order for the strategic application of each method. The following general framework is applicable to most incidents.

Dilution is a washing using water to flush the hazardous material from personal protective clothing and equipment. Fire fighters tend to use this method first, because water is readily available and can be used liberally. The advantages of dilution are speed and economy. The disadvantages are the possible reactivity of water with some materials and the pollution created by runoff. Remember: the application of water to most hazardous materials generally reduces concentration, in many cases it does not change the material chemically. Containment of the wash water may be necessary, depending on the product involved.

Absorption is the process of absorbing or "picking up" the hazardous material to prevent enlargement of contaminated areas. This technique is used primarily for decontaminating equipment and property. It has limited application for decontaminating people.

The most readily available absorbent is soil. Other acceptable materials include anhydrous fillers, sand or commercially available products such as Attaclay. Materials used for absorption should be inert. Many other absorbents are on the market; however, their success in decontamination situations has not been evaluated fully by the manufacturers or the potential users. More testing and information sharing is needed.

The advantage of absorption techniques is their ability to minimize surface areas of the spill when liquids are involved. They are also inexpensive and readily available. Although there are exceptions, the application of absorption materials usually is limited to flat surfaces such as the ground. It is important to remember that the contaminants in absorbents remain chemically unchanged and retain their hazards. In other words, a litre of PCB - contaminated transformer oil - spilled on the ground is still the same oil after it has been soaked up by an absorbent.

Chemical Degradation is the process of altering the chemical structure of, or neutralizing the hazardous material on equipment. The most commonly used chemicals are sodium hypochlorite (household bleach), sodium hydroxide (household drain cleaner), sodium carbonate slurry (washing soda), calcium oxide slurry (hydrated lime), liquid detergents and ethyl alcohol. The literature search conducted for this paper indicates that all of these chemicals have been used in actual incidents for decontamination. Technical advice for chemical degradation should be obtained from the manufacturer of the product.

The principal advantage of chemical degradation is that the hazardous material is rendered less harmful than it was prior to decontamination. The disadvantages are the time restrictions required to determine the right chemicals for the job and the immediate availability of the necessary materials. Also, after chemical degradation, a cleaning and washing to prevent further damage may be required.

Site Selection And Management

Before beginning decontamination, the incident commander must decide how much is necessary and to what extent decontamination will be accomplished in the vicinity of the spill. The decision whould be based on the answers to the following questions:

1. Are existing resources immediately available to decontaminate personnel and equipment? If not, where can they be obtained and how long will it take to get them?

2. Can decontamination be conducted safely? Dilution, for example, may be impractical due to cold weather or may render equipment unsafe. Some equipment can never be decontaminated, disposal may be the only method of handling such equipment safely.

The selection of a decontamination site should be based on access to the incident by hard-surfaced roads, on access to water supplies, and on the proximity of environmentally sensitive areas, such as streams and ponds.

An upwind, up-terrain area is, theoretically, an ideal decontamination site but is sometimes impractical. Shifting winds and the size of migrating gas clouds should be taken into consideration to avoid moving the operation once it is functioning. Sites farther than 100 yards from the incident will require transportation. Incidents requiring the use of SCBA and encapsulated suits will compound transportation problems. Experience in the field has shown that the best vehicle for transporting workers to and from a site is a pickup truck. Workers in encapsulated suits can ride in a truck bed with equipment. Drivers must wear respiratory protection too. Ideally, decontamination sites should be close to the incident to limit the spread of contaminants. Decontamination conducted off-site at fire stations and hospitals, for example, complicates the procedure. Nevertheless, decontamination at one location may be unsuitable and a combination of on and off-site decontamination stations may be required.

When a suitable site has been selected, an isolation perimeter should be established. This warns fire fighters of the hazard and identifies where personnel should go for decontamination. The area easily can be marked with stakes and rope or banner tape. Warning signs marked: "DANGER-CONTAMINATED AREA." should be placed will in advance of the danger.

If extensive decontamination is required, a responsible person should be placed in charge. This individual will confer with specialists, such as chemists and industrial hygienists, to determine which decontamination methods will be used, how much decontamination is required, and how much will be completed at the incident site. The authority and duties of the decontamination officer should be spelled out in written standard operation procedures.

Standard Operating Procedures

When decontamination is required, some on-scene strategy is necessary to help ensure the best chance for a safe operation. The basic building blocks of any response plan are daily operating procedures. Each emergency response agency should develop its own operating procedures. The following guidelines have been developed based on the practical application of established basic operating principles. The conditions under which they will be applied will never be ideal.

In most situations, it will not be necessary to go through the entire procedure. The decision to implement all or part of the decontamination process should be based on a field analysis of the hazards and risks of the materials involved. This generally consists of checking with technical reference sources to determine the general hazards, such as flammability, corrosiveness and toxicity, and an evaluation of the relative risks. It should be pointed out that most refernece books and technical resources available to emergency response personnel do not yet spell out how to decontaminate either personnel or equipment. In some cases, technical data and advice from experts may be oonflicting and difficult to obtain. In either case, use joint decision making.

Reference guide data combined with general on-scene reconnaissance normally will provide enough information to make an immediate decision on how to decontaminate personnel safely.

Overview of Decontamination

To determine what decontamination procedure is necessary, industrial hygienists, toxicologists, and technical references are consulted to evaluate the hazards of the material. Answers are sought to a number of questions. What are the health hazards? What effect does it have on skin? Is it toxic? What is its reactivity? What is its solubility?

Protecting people is the first priority, environment and property is the second.

Isolation and disposal are methods used for any equipment which cannot be successfully decontaminated by other methods. The equipment is placed in a designated area and later disposed of properly, ie. specially approved landfills.

Lethality of the materials involved must be evaluated. Some of the immediate effects of high-level, brief exposures include burns, rashes, nausea, loss of eyesight and poisoning. Effects of poor decontamination include cancer, birth defects and other reproductive problems, kidney damage, neurological disorders, chronic skin disease and acute poisoning. Prolonged exposure to low doses of certain materials can cause chronic lung disease, heart disease or sterility.

It has been generally agreed by experienced personnel, that no single reference source will provide the information necessary to evaluate the hazards and risks of hazardous materials. Always consult more than one source. Most response personnel should discuss how to handle conflicting information, who to trust and who is responsible for obtaining information. It would be desirable to have a representative of the manufacturer, shipper or receiver of the product on the scene of an incident to provide technical data. Canutec can provide emergency responders with advice on contacts to help get these people on the scene.

A hot line should be established outside the evacuation area, which would be up wind and on a higher terrain, if possible, from the incident and decontamination procedures for anything or anyone brought out of the evacuation area.

Decontamination areas should be organized to direct flow of personnel in a straight line from the dirty end (control point) to the clean end (exit point).

Officers should be aware of any cuts, wounds, lesions, or abrasions that their crews may have. If the apparatus is sent to an incident involving Hazardous Materials, such personnel should, wherever possible, exercise special care to avoid the chance of contamination through such wounds. Chemical absorbed through the skin will be absorbed much faster if the skin is cut or abraded, thereby presenting a serious health hazard.

Decontamination - Methods

These guidelines have been developed for the Halifax Fire Department, by members of the Dangerous Goods Response Team, by researching and combining the efforts and resources that have been made available through the Canadian Association of Fire Chiefs, the Toronto Fire Department N.F.P.A., and Canutec. It should be noted that these are guidelines - not standards - and that special circumstances may require modified or additional procedures.

Guidelines for Preparing Decontamination Solutions

General decon and cleaning compounds
- 5% sodium carbonate - washing soda
- 5% trisodium phosphate - Spic & Span
- 10% calcium or sodium hypochlorite - Swimming pool cleaner
- hydrochloric acid - 5 litres to 40 litres water
- detergent (mixed into a paste)

1. When dealing with unknowns under emergency conditions:

Decontamination solutions are water and chemical compounds designed to react with and neutralize specific contaminants. The temperature of the liquid and the contact time should be given consideration to be sure complete neutralization has taken place. In many cases, fire fighters faced with an unknown hazardous material will require a washdown and decontamination after leaving the "hot zone". The following solutions should be used for unknowns, since they are effective for a variety of contaminants.

Decon solution A - A washing solution containing washing soda and Spic & Span. Mix 2 Kg. of commercial grade washing soda and 2 Kg of commercial grade Spic & Span with each 40 litres water. These chemicals are available in most hardware stores. Hose down with water, scrub with washing solution and rinse.

Decon solution B - A solution containing calcium or sodium hypochlorite. Mix 2 Kg. of swimming pool cleaner with each 40 litres of water. Calcium hypochlorite is available from swimming pool supply stores. Make sure you purchase it in plastic containers or transfer it from cardboard drums into clean plastic buckets marked "oxidizer".

A general purpose rinse solution for both decon solutions is a 5% solution of Spic & Span. To prepare the rinse, mix 2 Kg. Spic & Span with each 40 litres of water. An attempt should be made to collect the run-off from these washings to prevent further contamination.

2. Decon using degradation chemicals for known materials:

Five general purpose decon solutions are available for ten basic hazard classes. These are:

Decon solution A - A solution containing 5% sodium carbonate/washing soda and 5% trisodium phosphate/Spic & Span. (2Kg. washing soda and 2Kg. Spic & Span in 40 litres water)

Decon solution B - A solution containing 10% calcium hypochlorite/Swimming pool cleaner (COP) (2Kg. in 40 litres water)

Decon solution C - A solution containing 5% Spic & Span. This solution can also be used as a general purpose rinse. (2Kg in 40 litres water)

Decon solution D - A diluted solution of hydrochloric acid (HCI). Mix .5 litres of concentrated HCI into 40 litres of water. Stir with a wooden or plastic stirrer.

Decon solution E - A concentrated solution of Tide or other detergent and water. Mix into a paste and scrub with a brush. Rinse with water.

The following chart should be used as a guideline for selecting decon solutions for the type of hazard identified:

1. Inorganic acids, metal processing wastes - Decon solution A
2. Heavy metals: mercury, lead, cadmium, etc. - Decon solution B
3. Pesticides, chlorinated phenols, dioxins and PCBs - Decon solution B
4. Cyanides, ammonia and other non-acidic inorganic wastes - Decon solution B.
5. Solvents and organic compounds such as trichlorethylene, chloroform and toluene - Decon solution A or C
6. PBBs and PCBs - Decon solution A or C
7. Oily, greasy unspecified wastes not suspected to be contaminated with pesticides - Decon solution C
8. Inorganic bases, alkali and caustic wastes - Decon solution D
9. Radioactive materials - Decon solution E
10. Etiologic materials - Decon solution A or B

Caution: The decontamination solutions listed above are recommended for ten general groups of hazardous materials. Always contact expert assistance from manufacturers, poison control centers, medical specialists, etc., to determine the best solution to use. In the meantime wash with water and scrub with Decon solution C.

Decontamination Procedures (instructions for the decontamination of Fire Fighters and their clothing, after dangerous goods incidents).

There are 6 levels of decontamination:

Level "A" - The most common. A final cleaning that needs only be done at the station.

Level "B" and "C" - Decontamination of clothing and equipment that needs to be started at the scene of the incident, as well as being continued upon return to the station.

Level "C" - Used for PCBs, cyanides and few others which will involve the destruction or drum storage of all clothing worn.

Level "D" - Dry decontamination for water-reactive and certain dry substances, followed by one of the other levels of decontamination, which will be dependent on the substance involved.

Level "E" - Decontamination of etiologic agents that must be carried out at the scene and procedures followed on return to stations.

Level "F" - For radio-active materials.

These procedures are to be instigated if personnel are known or suspected to have been directly exposed to the chemical splashes, its vapors, or products of combustion, etc.

When an incident is encountered with the product identified and the initial responder comes in contact with the product the level of decontamination will be determined by using the NFPA Guide on Hazardous

Materials. Under Section 325M, the chemical names are listed alphabetically. When the chemical name is located, the health hazard number (3rd column from the right) is taken and rated as follows:

Numbers 0,1, or 2 - Level "A" Decontamination
Number 3 - Level "B" Decontamination
Number 4 - Level "C" Decontamination and wear SCBA

If the chemical cannot be found in the NFPA Guide on Hazardous Materials, use the orange Canutec Emergency Response Guide for Dangerous Goods. Locate the appropriate Hazard Page. Under "Health and First Aid Comments", if the words "Poisonous or Fatal if Inhaled" are mentioned, use Level "B" and wear SCBA. Ohterwise use Level "A", unless you feel another level would be safer, due to other information known to you.

If the nature of the chemical remains unknown and it is necessary to commit emergency forces to the hazard sector, complete decontamination procedures are implemented (Level "C"). As a knowledge about the hazard is gained, the process can be downgraded as necessary.

How much decontamination is required is determined by a number of factors. The type of contaminant and the degree of exposure ie.; spill splash, dust, spray or gas is a consideration when determining the decon Level. Highly toxic or skin destructive substances require the greatest decontamination effort. The amount of the contaminant and the location of the contaminant on the workers are other considerations. The level of protection worn by workers is another factor. For some contaminants, protective clothing can never be adequately decontaminated and must be disposed of.

Always wash with water before leaving the hot zone and at least scrub the part of the clothing that may be contaminated.

LEVEL "A"

Upon Return to Station:

1. Wash down all fire fighting clothing with a solution of trisodium phosphate (Spic & Span) and water. Rinse with water.

2. Wash Scott facepiece, cylinders, backplate and harness with trisodium phosphate and water solution. Take care to wipe, not scrub, around regulator assembly. Rinse with clean water. Disinfect facepiece with Scott disinfectant. If damage is suspected to any part of the breathing apparatus, or if the chemical is known or suspected of deteriorating the components that make up the breathing apparatus, return it for service after decontaminating. Be sure to tag the unit.

3. Scrub hands and face with soap and water.

NOTE: It may be necessary to wear breathing apparatus while decontaminating clothing and equipment.

LEVEL "B" FOR MEDIUM HAZARDS

At the Scene

1. Members assigned to decontamination task will wear SCBA and full turnout gear.

2. Do not remove SCBA facepiece. Remove helmet.

3. Member assigned task of decontamination, to flush fire fighter from head to toe with copious amounts of low pressure water from open end of fire hose. Include mask, harness and backplate, cylinder, boots to the top, inside of coat wrists to the cuff, under collar and inside and outside of helmet, scrub with brush. Contain this water for later disposal.

4. Do not eat, drink, smoke, void or touch face.

Upon Return to Station

5. Maintain temporary "Code 7" status.

6. Remove all turnout gear (Coat, belt, boots, helmet, bunker pants), remove liner from helmet, scrub all items, including helmet, inside and out with trisodium phosphate (Spic and Span) solution. Rinse with copious amounts of water and contain this water for later disposal.

NOTE: It may be necessary to wear breathing apparatus while washing down turnout gear.

7. Scrub full protective kit items (if worn), gloves and breathing apparatus likewise. Be sure to flush out gloves with water. If breathing apparatus has been stored inside a case or in a compartment, while returning to station, scrub and rinse also.

8. Remove all clothing worn at scene and place in a yellow garbage bag for laundering by H.F.D. Label garbage bag with yellow tag, indicating your name and platoon, and the comment "Dry Clean Only". Include a list of the items.

9. Shower thoroughly, washing all of the body with soap and water, with particular emphasis on areas around the mouth and nostrils and under the fingernails. Shampoo hair and thoroughly clean moustache, if you have one.

10. Do not eat, drink, smoke, touch face or void until Step "9" is completed.

11. Put on clean clothes.

12. Do not put apparatus back in commission until clean up is completed, including scrubbing of breathing apparatus compartment or case and the area where the fire fighter was seated while returning to quarters.

LEVEL "C" FOR EXTREME HAZARDS

At the Scene

1. Do not remove S.C.B.A. Facepiece. Remove helmet.

2. Provided the chemical is not water reactive, the member assigned the task of decontamination, wearing one level of protection below that of

the contaminated fire fighter, is to flush him from head to toe with copious amounts of low pressure water from the open end of a fire hose. Include the mask, harness and backplate, cylinder, boots up to the top, inside of coat wrists to the cuff and inside and outside of helmet. Contain water for later disposal.

3. Do not eat, drink, smoke, touch face or void.

4. Put S.C.B.A., used cylinders and all equipment known or suspected of being contaminated, in yellow garbage bags. This includes tarps, hand tools, hose, etc. Seal bags, tag and return them to the station. Where circumstances permit, remove and bag fire gear also.

5. Where encapsulated suits are worn, the following procedure is to be carried out:

   (a) Flush from head to toe with copious amounts of low pressure water. Contain water for later disposal.

   (b) When there is an adequate amount of air supply remaining to allow for chemical degradation, a scrub down of the suit will be carried out prior to removing any part, using the required decontamination solution.

   (c) During removal of the encapsulated suit, care should be taken by personnel not to touch the exterior surface, thereby minimizing the contamination of personnel and equipment that has been protected to this point.

   (d) After removal, the suits that are known or suspected of being contaminated will be placed in steel drums for testing by an appropriate agency.

Upon Return to Station

6. Keep apparatus temporarily "Code 7".

7. If bags are returned from incident, put in an exterior cordoned off area.

8. Strip completely, including underwear and socks. Place all clothing (turnout gear and personal clothing) in yellow plastic garbage bags. Place portable radio in separate yellow bag. Seal and label each bag as to contents and place in exterior cordoned off area.

9. Request the required number of disposal drums you estimate you will require. Upon their arrival, seal garbage bags with contaminated items in the same drums.

10. Place the drums in an exterior cordoned off area - minimum 5 meter radius.

Note: Drums will be picked up and contents analyzed. Some of the items may require destruction. Some may be able to be decontaminated and returned.

11. Shower, washing all of the body with soap and water, with particular emphasis on areas around the mouth and nostrils and under the fingernails. Shampoo hair and thoroughly clean moustache, if you have one.

12. Do not eat, drink, smoke, touch face or void until step "11" is complete.

13. Put on clean clothes.

14. Report to hospital for medical evaluation. Inform physician which chemical was involved.

15. If apparatus is known or suspected of being contaminated, completely wash apparatus, including underneath. Pay particular attention to any area where fire fighters may have been sitting.

16. Contact maintenance division to have air filter(s) changed, as it may be laden with particles.

17. Apparatus may now be placed "Code 5".

Note: Personnel known or suspected of having been in contact with a chemical requiring this level of protection, should be transported back to stations, only after a medical check up and the approval of the incident commander. This step will eliminate needless contamination of additional equipment and stations.

Special Instructions and Resources

1. Steel drums will be required. Determine the number and location. The department stocks drums for this purpose and they are stored at station #6. Arrange for the required number to be picked up as soon as possible and delivered to the stations concerned.

2. For testing of drum contents with a view to decontamination, contact "Environment Canada - Environmental Protection Service". This applies to most chemicals, including PCBs.

3. For radioactive materials, contact the "Nova Scotia Department of Health" - Radiation Health Protection Officer.

4. The Platoon Chief to detail an office to attend to testing and decontamination, to determine whether it is cost effective to continue to work on any items giving problems, or whether these should be disposed of.

5. In the event items must be disposed of, the following procedures apply:-

Chemical Contamination

Seal items in yellow garbage bags, place in steel drums, label drums and contact "Nova Scotia Department of the Environment" for disposal approval. They will advise you on the appropriate location for disposal. The Department will arrange for, and oversee disposal.

LEVEL "D" FOR WATER-REACTIVE HAZARDS- Radioactive exposures and dry pesticide incidents, where water must not be used.

At the Scene

1. Set up a suitable vacuum-cleaner with power supply. Provide a dry brush and a containment capture method for materials falling off the contaminated personnel. Assistants to don full turnout gear and S.C.B.A., with disposable chemical suits if available.

2. If this is a radiation incident, the fire fighters suspected of being contaminated will be scanned carefully with a radiation monitor suitable for detecting surface contamination. All parts of their clothing, personal equipment will be scanned, including the soles of the boots. If no readings are found, the personnel that have been checked can leave the decontamination area.

3. If this is a water-reactive incident, or if the fire fighter was found to be radioactively contaminated, stand fire fighter in centre of containment area - clean helmet inside and out.

4. Commence cleaning from head downward, include all external areas. Slacken S.C.B.A. harness to allow cleaning behind straps and backplate.

5. When the fire fighter has been fully vacuumed or brushed off, he will step out of the containment area. As he does so, his boots including the soles must be cleaned off so any contaminant will remain within the containment area. Move to main decon area as per step #6.

6. Procedures will then continue as follows:
   - Radioactive Incident - Go to level "R" Routine
   - Dry Pestice Incident - Go to level "E"
   - Other Incidents - Go to level "E" Routine (unless advice is received that another level is more appropriate).

7. All used filters and collected waste are to be placed in a garbage bag, sealed and tagged, and disposed of in a manner acceptable to the agency having jurisdiction.

LEVEL "E" FOR ETIOLOGIC HAZARDS

Etiologic Agents - Means a viable microorganism or its toxin, which causes or may cause human disease. Contact with this material must be avoided.

Whenever packages are discovered leaking in transit and bearing the label "Etiologic Agent", all unnecessary movement of the vehicle must be isolated. Any contact with these types of chemicals must be treated with a decontamination procedure Level "E", at the scene.

At the Scene

1. Flush the fire fighter from head to toe with low pressure water. S.C.B.A. facepiece can now be removed. Place helmets in black garbage bags and seal. Place surgical mask on fire fighter.

2. Spray the fire fighter's boots and any tools, hose or other equipment used (but not portable radios and not bunker gear) with a 5-6% bleach solution from a spray can. Take note of the bleach concentrate percentage when calculating the makeup. The javex brand we carry is 12%, so a 50-50 water solution would be needed. Let stand for 10 minutes and flush with water.

3. Remove S.C.B.A., place in black plastic garbage bag, seal and tag. Remove fire fighter's turnout gear and gloves, place in yellow garbage bags, seal and tag. Place portable radios in black garbage bags, seal and tag. Discard surgical masks.

4. Do not eat, drink, smoke, or touch face.

5. Before leaving the Scene, a fire fighter wearing S.C.B.A., should attempt to spray as much of the exposed ground as possible, and wash down bleach solution with water, then flush the outside of the spray can with water.

6. Before leaving the scene, place all yellow garbage bags into an orange sterilization bag (nylon) and pull the drawstrings. Snap the sliding buckle to the locked position.

Upon Return to Station

7. Place apparatus temporarily "Code 7".

8. One fire fighter should dress in fire gear, a S.C.B.A., disposable surgical gloves, and in an outside area, perform the following tasks:

   -Open the black plastic garbage bags one at a time, wipe all helmets, portable radios, S.C.B.A. sets and cylinders with a rag dampened with a 6% bleach solution.

   -After 10 minutes, wipe these items again with a rag dampened with clean water.

   -Seal all used black garbage bags and rags into another bag and put out for normal garbage pick-up. Empty the spray can and flush out to remove bleach residue.

9. Remove all clothing worn at the scene, including socks and underwear and place in yellow garbage bag for laundering by H.F.D. Label garbage bag with dangerous goods tag, including your name, platoon, station and contents. Include the instruction, "Dry Clean Only " and "Sterilize".

10. All personnel should shower, washing the entire body with soap and water, with particular attention to the areas around the mouth and nostrils and under fingernails. Shampoo hair and thoroughly clean moustache.

11. Do not eat, drink, smoke, touch face or void until step #10 is complete.

12. Put on clean clothes. Place apparatus back in commission, only when decontamination is completed. Notify P.B.X. of the number of sterilization bags and garbage bags awaiting pick up. All bags must be tagged with station and platoon.

NOTE: Black garbage bags are to be used for items retained at the station, yellow bags are for items sent away for sterilization or disposal.

LEVEL "R" FOR RADIOACTIVE HAZARDS

At the Scene

Preparation

(A) Mark off a decontamination area with two parts.
(B) Make up a solution of detergent and water, obtain scrub brushes.
(C) Set out a reserve air supply.
(D) In the first part of the decontamination area, set up a runoff capturing method, either with wading pools or through the use of tarpaulins.
(E) If appropriate, a "walkway" of polyethylene sheeting (weighted down if necessary) can be placed from the exit from the incident scene to the decontamination area, to prevent possible contamination of the ground.

2. The decontamination crew will don S.C.B.A. and disposable chemicle suits.

3. The fire fighters suspected of being contaminated will be scanned carefully with a radiation monitor suitable for detecting surface contamination. All parts of their clothing and personal equipment will be scanned including the soles of the boots. If no readings are found, the personnel that have been checked can leave the decontamination area.

4. Personnel found to be contaminated will be scrubbed down thoroughly with a detergent solution by the decontamination crew. This is followed by a flushing off using low pressure water, Efforts should be made to capture the runoff.

5. The fire fighters will then move to the second part of the decontamination area, where they will be scanned again with the radiation monitor. If any readings are found, they will return to the first part of the decontamination area and step # 4 will be repeated.

6. When all personnel have been cleaned of contamination, the decontamination crew themselves will be hosed down. The matter of the captured runoff water will be discussed with environmentat authorities, and disposal arranged in a manner acceptable to them.

7. In the event fire fighters being decontaminated run out of breathing air, the reserve supply set out in step #1 will be passed to them. They should hold their breath while changing facepieces.

8. In the event that, despite repeated scrubbing, any fire fighters cannot be decontaminated, they will remove as much of their clothing as possible in the second part of the decontamination area, and don clean or spare clothing. The clothing that has been taken off will be sealed into garbage bags and returned to the station. This evolution must be executed in such a manner as not to contaminate the clean clothing.

9. Any equipment suspected or known to be contaminated will be sealed into garbage bags and returned to the station.

On Return to Station

Follow the Level "C" procedure steps #6 to #17 for those firefighters who were found to be contaminated in stip #3 above, and for any contaminated equipment.

Radioactive Materials

The "Nova Scotia Department of Health" will advise and supervise disposal of radioactive materials, as well as providing assistance in monitoring exposure levels.

GLOSSARY OF DECONTAMINATION TERMS.

Absorption - the process of picking up or taking a hazardous substance to prevent the enlargement of the contaminated area.

Baseline Study - a medical evaluation of a person's health at a given point in time, which may include lung and blood tests, urinalysis, electrocardiogram and test of liver and kidney functions. Baseline studies can assist in determining the effects of later contact with hazardous substances.

Contaminant - harmful substance which may be in the form of solids, liquids, vapors, gases, mists, or particles in the air.

Decontamination - the process of making personnel, equipment and apparatus safe following exposure to hazardous substances, by removal of the substance or residue of the substance.

Degradation - a method of decontamination in which the chemical structure of the hazardous material is altered by mixing it with another reactive chemical; the goal is to transform the hazardous material into a less harmful substance.

Dilution - a method of reducing the concentration of a chemical to a level at which it is no longer harmful; water is usually used, except when the possibility of a chemical reaction exists.

Disposal - method used for decontamination of supplies and equipment with porous parts which cannot be decontaminated by other methods; items placed in plastic bags and segregated for later removal to specially approved landfills or other approved sites.

Encapsulating Suits - chemical protective clothing which fully encloses wearer who uses S.C.B.A.; provides highest level of respiratory, skin, eye and mucous membrane protection; used when extremely hazardous substances are known to be present.

Entry Point- point at which workers leaving the hot zone or hazard sector enter the decontamination sector; contaminated equipment, boot and glove covers usually discarded before this point.

Exit Point - the point where workers depart the decontamination area, in preparation to be evaluated by medical personnel.

Hazards - the inherent characteristics of a material that may cause injury, incapacitation or death by contact, inhalation or ingestion.

Hot Line - a line which divides the hot zone or hazard sector and the area where principal decontamination takes place.

Hot Zone - the area where the spill, leak or fire has taken place and where contaminants may be present; sometimes called the hazard sector.

Incident Commander - person responsible for on-site management of all activities at a hazardous materials emergency.

Isolation Line - the point where workers have received primary decontamination and their S.C.B.A. can be removed. This is the point where workers can re-enter the incident area with a reserviced S.C.B.A. or carry on to the fixed decontamination facility.

Isolation - a method of handling contaminated equipment and supplies in which the contaminated items are bagged or covered and set aside, usually for subsequent shipment to an approved landfill for disposal.

Materials Safety Data Sheet (MSDA) - form required under Occupational Safety and Health (OSHA) legislation which provides important information about a chemical, including emergency action guidelines, permissible exposure limits, medical information and other data; should be available at facilities in which the chemical is used, stored, or manufactured or at manufacturing headquarters.

Matrix Contamination - a situation in which chemicals are absorbed into the fabric of protective clothing and continue to permeate the protective clothing and diffuse toward the inside, even after surface decontamination procedures have been carried out. In such a situation, protective clothing may have to be disposed of.

Permeation - the process by which a chemical dissolves in or moves through a protective clothing material on a molecular level.

Porous - describing any substance capable of being permeated by a chemical including wood, leather, and fabric.

Reactivity - the reciprocal action of chemicals upon each other; this action usually causes the creation of new chemicals.

Risk - exposure to the chance or injury of loss; whereas hazards of materials remain constant, the risk can be varied by emergency response personnel.

Solution - mixture of one or more substances in another substance, usually a liquid in which all the ingredients are completely dissolved.

Symptom - a sign that arises from and accompanies a particular disease or disorder and serves as an indication of it; symptoms of disorders arising from contact with hazardous substances may not occur for hours, days, months or even years following contact with the substance.

Toxic Material one which can pass through a body surface, i.e., skin, lungs, eyes, or digestive tract, and enter the blood stream and cause bodily harm by chemical action.

05-Oct-1988

Guidelines for Decontamination At Transportation and On-Site Chemical Emergencies

Basis: Decontamination Procedures/Guidelines prepared by C-I-L hygienists, 1987.

1.0 Introduction and General Principles:

Decontamination of personnel and equipment at an emergency scene may be critical for health and safety during or following emergency response. On-site decontamination (decon) is a first step only; it must be simple and quick, but adequate to prevent the spread of contaminants and protect personnel and equipment from hazardous substances during equipment use and reuse on the scene, and when taken back to home base. It must be followed at home base by thorough secondary decontamination to protect the equipment and ready it for reuse, or the equipment must be discarded safely.

On arrival at an emergency scene, and before entering a potentially contaminated zone, the emergency team leader must develop a site safety plan, and a decon plan. Note that site "safety plans" and "decon plans" do not have the same purpose. The site safety plan provides for such things as safety showers, eye wash fountains, first aid, etc for immediate use in case of emergency. The decon plan provides for an ongoing effective method of cleaning personnel or contaminated equipment leaving the contaminated area, for protection of personnel, equipment and the clean area from hazardous material which has contacted equipment or protected personnel.

These procedures will assist ER personnel in developing an on-site decon plan, at either transportation or plant incidents, and deciding what procedures and equipment are appropriate.

The following decon procedures assume that appropriate personal protective equipment (PPE) is being worn. They apply when there has been no personal contact with the hazardous substance. The decon procedures are intended to prevent future contact and protect personnel from possible inadvertent exposure, and to clean the equipment, to protect it and permit reuse. A "decon assistant", suitably protected, is virtually essential for adequate decontamination if there has been any contact with hazardous material.

Special procedures are suggested for removing all types of protective clothing after use (Section 4, below) to minimize risk of contamination on the clothing contacting the wearer, the decon assistant or the interior of the clothing. These should always be used, even when no contamination is suspected, or contamination is believed to be minimal.

Persons removing personal protective clothing must not smoke, eat, drink or touch face or body until hands and face are scrubbed.

If a hazardous material has contacted the person of a responder, emergency action must be taken to remove contaminated PPE and clothing quickly, to permit treating the exposure and prevent further contact. If normal work clothes are contacted by serious contaminants, they must be removed as quickly as possible, possibly under a safety shower, and the injured person cleaned and treated as appropriate. The contaminated clothing must be carefully handled to prevent contamination of the clean area. Those assisting must take care to protect themselves and the injured person against further exposure.

During decontamination, it may be necessary to collect washings to avoid the contaminant entering the environment. Use of wash water may have to be minimized or wash water collected and treated in case of serious contaminants.

Following on-site decontamination and preliminary cleaning, equipment must be safely carried back to the base location and thoroughly cleaned, inspected and reconditioned for reuse. Frequently emergency equipment can't be restored to a satisfactory state after contamination, or can't be completely decontaminated, and must be discarded in a safe manner.

Note that decontamination procedures can be greatly simplified if disposable protective equipment can be used. This is a viable option under some circumstances; however care must be taken to ensure the disposable garment chosen is sufficiently rugged, durable and impermeable for the expected service. The following procedures are still used to protect the wearer during doffing of the disposible clothing, and it must be disposed of safely. Disposable clothing will generally be adequate for the decon assistants.

2.0 Planning for Decontamination.

2.1 At the incident scene, develop a site safety plan (eg safety showers, eye wash) and a site decontamination plan (see below) and put them into effect before any personnel or equipment enter areas where there is potential for exposure to hazardous substances.

Include in your decontamination plan :

a) Layout of decon areas, between contaminated ("hot") and clean areas; consider a flush-down area, wash-down area, undressing area, personal wash area.
b) Level of decon needed, based on contaminants and degree of exposure;
c) General decon equipment required and where;
d) Procedures and equipment:
    1) To decontaminate exposed personnel and equipment
    2) To prevent contamination of clean areas
    3) To minimize contact and protect personnel during removal of PPE.
    4) To avoid contaminants entering the environment.
    5) To store and transport contaminated equipment to home base.
    6) To dispose of clothing and equipment that can't be decontaminated.

2.2 Movement of personnel to and from the hot zone must be minimized, to minimize the spread of contaminants and the need for decon. For example, tools and supplies needed by workers in the hot zone should be delivered to them at the hot zone boundary, rather than them crossing to the clean zone to get them.

2.3 Preliminary cleanup of equipment should be carried out as soon as practical, preferably while leaving the hot zone, to minimize the spread of the contaminant around the emergency scene, and absorption or penetration into the clothing.

2.4 If someone is required to reenter the contaminated (hot) zone following the removal of contaminated PPE, unused or uncontaminated equipment should be used if possible, rather than reusing the contaminated PPE, to minimize the risk of secondary contamination inside the PPE from repeated donning and doffing.

3.0 Decon Procedures:

3.1: Level A Decon Procedure:

a) When to use:

This is the basic cleanup procedure, for minor decontamination and cleaning of equipment, to be used whether or not contamination is suspected, following any use of PPE in any emergency situation, especially where minor spills or vapors may be present. Applies to all levels of protective clothing.

b) Principle:

The protective clothing and equipment is washed, brushed and rinsed with water and detergent to clean, make safe and remove minor contamination, then made ready for potential reuse.

It is recommended that the washing be carried out while the workers are still wearing their PPE, with a decon assistant to help; this is largely because of the greater ease of handling the protective equipment while still being worn. If preferred, the equipment can be removed with care before cleaning (use PPE removal procedure 4.1, below).

c) Equipment Needed: TO BE COMPLETED LATER

d) Protection for Decon assistant:

Basic waterproof protective clothing; goggles; face shield or hood if hazardous material contact possible. Disposable clothing is generally suitable.

e) Detailed Procedure A:

1. Wash down all protective clothing with water and detergent, eg TSP solution, and rinse with water. Use brush for folds, joints, seams, etc. Collect water if necessary to protect the environment.

2. Move to disrobing area and remove PPE using the proper techniques as described in section 4.1. Leave protective clothing right-side-out, to avoid contamination of the inside.

3. Complete cleaning of PPE if necessary, and ready for reuse if desired. Note: It may be necessary to wear breathing apparatus while washing down and cleaning protective clothing if it is contaminated.

4. Wash down full facepiece masks, cylinders and harnesses of SCBA with detergent solution. Take care to wipe, not scrub around regulator assembly. Rinse with clean water. If damage is suspected to any part of unit, tag and put aside to prevent reuse, and return for servicing. Disassemble cartridge respirators, and wash and rinse as above.

5. Scrub face and hands with soap and water.

3.2: Level B Decon Procedure:

a) When to use:

Use following possible contact with any hazardous substances which are:

i) Skin absorptive (eg carbon tet, CS2)
ii) Corrosive (eg caustic soda, acids, diethanolamine)
iii) Reactive (eg sodium chlorate, picric acid)
iv) Water soluble (eg sodium cyanide, ethylene glycol)
v) Water insoluble and low viscosity. (eg propylene glycols)

b) Principle:

With all PPE including respiratory equipment/SCBA still being worn, and with facepiece in place, the responder is flushed down with water to remove gross contamination, then brushed down with water and detergent, by a decon assistant. Wash water is collected if necessary for environmental protection. Protective clothing is then removed properly and further cleaned and readied for reuse, or bagged. The responder scrubs with soap and water.

Do not smoke, eat, drink or touch face or body until hands and face are scrubbed.

c) Equipment Required: TO BE COMPLETED LATER

d) Protection for Decon Assistant:

Basic waterproof protective suit, taped at wrists and cuffs, goggles, with face shield, hood and breathing equipment as necessary depending on the chemical and degree of contamination. Disposable clothing is generally suitable.

e) Detailed Procedure B:

1. Assistant flush contaminated personnel from head to toe with much low pressure water, including mask, harness, boots up to the top, inside of coat wrists to the cuff, inside and outside helmet, etc. Collect water if necessary to protect the environment.

2. Assistant wash and brush down personnel still wearing PPE with detergent solution, and rinse with water, using brush for folds, seams, etc.

3. Move to disrobing area and remove PPE properly, as per section 4.1. Keep protective clothing right-side-out, to minimize internal contamination. Clean PPE further if appropriate, and ready for make reuse if necessary (avoid reuse if possible).

4. Consider removing outer clothing worn at scene (if there is any risk of contamination) and place in labeled garbage bags for cleaning.

5. Wash down respiratory equipment with detergent, taking care to wipe, not

scrub, around regulator assembly. Rinse with clean water. If damage is suspected of any part of the unit, tag and put aside to prevent reuse, and return for servicing.

6. Place contaminated equipment which is not completely cleaned or not required for reuse in containers to return to base location for final decon. Keep right-side-out, and roll carefully. Segregate according to degree of contamination, type of equipment. Label with warning and details.

7. Scrub face and hands with soap and water. Shower at first opportunity, scrubbing all of the body with soap and water, with particular emphasis on areas around mouth and nostrils, and under fingernails. Shampoo hair, facial hair, etc. Do not smoke, eat, drink or touch face or body until face and hands scrubbed.

8. Report to C-I-L regional health personnel for clinical examination immediately on return to base location. Inform C-I-L health personnel which chemical was involved in operation which resulted in contamination, and degree of exposure.

3.3: Level C Decon Procedure:

a) When to use:

Use following possible contact with unidentified contaminants, or with more hazardous contaminants which:

i) Are water insoluble high viscosity materials that are skin absorptive, corrosive or reactive. (eg: PCBs, isocyanates)

ii) Are toxic by inhalation, with high volatility or airborne particulates. (eg: methylene chlorine, crystalline silica, butyl cellosolve)

iii) Have an immediate and measurable systemic effect. (eg: HCN, cyanide salts, some pesticides).

b) Principle:

With all PPE including SCBA still on, the responder is well flushed down with water. The assistant is also fully protected, including SCBA. The responder is then brushed down with water and detergent. When major decontamination is complete, protective clothing is removed with extreme care, treated as if still contaminated, and bagged for later decontamination or disposal. Immediate reuse is avoided. The responder scrubs with soap and water, then showers at first opportunity. Special care is made to collect contaminated washings.

Do not smoke, eat, drink or touch face or body until decon procedure completed.

b) Equipment Required: TO BE COMPLETED LATER

c) Protection for Assistant:

Full protective equipment, with SCBA, and hood or encapsulating suit, during first stages. The decon assistant remains protected until decon complete and contaminated equipment packaged for transport. Disposable clothing is generally adequate.

d) Detailed Procedure C:

1. Leave respiratory equipment/SCBA on. Assistant flush contaminated personnel well from head to toe with much low pressure water, including mask, boots to the top, inside of coat wrists to the cuff, inside and outside helmet, etc.

2. Assistant wash and brush down PPE with water and detergent using brush, with particular care at folds, seams, joints, etc. Rinse with water. Test for completeness of washing if possible.

3. Move to disrobing area and remove PPE carefully, treating as if still fully contaminated, using the procedure in Section 4.2. Keep right-side-out to minimize internal contamination.

4. If convenient, the decon assistant continue cleaning the PPE to minimize contamination of the clean area.

5. Wash down respiratory equipment face pieces, cylinders and harness with detergent equipment. Wipe, don't scrub, around the regulator assembly. Rinse with clean water. If damage is suspected to any part of unit, tag and put aside to prevent reuse, and return for servicing.

6. Store PPE, right-side-out and carefully rolled, in heavy wall garbage bags, sealed and labeled. Segregate according to degree of contamination, type of equipment.

7. Consider removing outer clothing worn at scene if there is any risk of contamination during use or removal of PPE; place in labeled garbage bag for laundering.

8. Scrub hands and face with soap and water. Shower at first opportunity, scrubbing all over with soap and water, with particular emphasis on areas around mouth and nostrils and under finger nails. Shampoo hair and thoroughly clean facial hair. Do not smoke, eat, drink or touch face or body until this is done.

7. Report to C-I-L regional health personnel for clinical examination immediately on return to base location. Inform C-I-L health personnel which chemical was involved in operation which resulted in contamination, and degree of exposure.

3.4 Emergency Decontamination, When Water Not Available.

a) Principle:

If protective clothing is contaminated and no water is available to wash off, remove as much of the contaminant as possible using any appropriate material available. Then carefully take off the still-contaminated clothing or equipment, with assistance from protected assistant. Isolate the contaminated equipment and dispose carefully of the material used to decontaminate.

b) Equipment required:

Anything available that can be used to partially decontaminate the PPE.
Packaging for contaminated PPE and for used decontaminant.

c) Protection for Decon Assistant:

Full protective equipment as appropriate to chemical and exposure. Disposable clothing will generally be suitable.

d) Detailed Procedure:

1. With help from protected assistant if necessary, remove as much of the contaminant as possible with any material available which will physically remove, absorb, solidify or dilute the contaminant;

For example:
- Rub with snow or crushed ice to remove/dilute;
- Rub with clay or sand to absorb, solidify, remove contaminants;
- Wipe with cloth, paper towels, newspaper, leaves, grass, etc to absorb or remove contaminants;
- Wipe with water based solutions available such as windshield washer fluid.

2. When cleaned as well as possible, move to appropriate area and remove PPE as described for grossly contaminated clothing, Sec. 4.2. Keep clothing right-side-out to minimize internal contamination. Roll up carefully.

3. At once bag, seal and label as grossly contaminated, for return to base for decontamination and/or disposal. Do not reuse until completely cleaned and checked.

4. Consider removing outer clothing worn at scene if there is any risk of contamination; place in labeled garbage bag for laundering.

5. Scrub hands and face, and shower at first opportunity. Do not smoke, eat, drink, or touch face or body until this is done.

4.0 Procedures for Removing Protective Clothing and Equipment

4.1. If believed clean, lightly contaminated or partially decontaminated.

1. Assistant to be protected against skin contact and inhalation hazard appropriate to the chemical involved.

2. Move to designated disrobing area, where access to clean clothing is relatively easy. Have necessary clean replacement clothing, footwear, etc on hand.

3. Remove all protective equipment, avoiding contamination of inner surfaces, as follows:
- Remove tape from cuffs if necessary
- Undo front of coveralls or jacket, pull back or shrug off shoulders and down back and arms.
- Remove gloves, cuffs first, and remove arms from sleeves
- Pull coveralls or pants down legs to boot tops, keeping unprotected hands on inside of garment. Step out of coveralls and boots, stepping clear of contamination.

- Remove breathing apparatus as appropriate, before or after removal of protective clothing, depending on circumstances.

4. Keep all protective clothing right-side-out, close fasteners if convenient and roll to minimize contamination of inner surfaces.

4.2. If assumed to be grossly contaminated.(eg unwashed, or Level C).

1. Assistant(s) to be fully protected with uncontaminated PPE.

2. Move to appropriate disrobing area, with easy access to clean clothing. Clean or temporary footwear at hand, clean clothing nearby.

3. Assistant remove the PPE from exposed person, turning clothing inside-out as removed, so assistant minimizes contact with contaminant, never touches exposed person, as follows:
   - Grasp gloves at cuff and pulled off from the hands;
   - Undo coverall or jacket from front, then pull off from shoulders down back and off the arms, and thence down the legs.
   - The exposed person steps out of the contaminated boots and coveralls or trousers simultaneously, put on clean or temporary footwear and move to clean area.
   - Remove breathing apparatus as appropriate, maintaining breathing, facial, eye protection as long as required.

4. As removed, return protective clothing to right-side-out, to minimize further internal contamination. Close fasteners if convenient, and roll for storage and transport in sealed, tagged bags.

5.0 Decon Equipment:

5.1: Required for On-Site Decontamination:

A. For cleaning:
- Source of water for washing and/or rinsing.
  (fire hose, garden hose, tank, pond or stream with portable pump, recirculated water using dunk tank and portable tank, etc)
- Shower facilities: shower assembly, shower heads for hose, with fittings
- Brushes: long handled, short handled.
- Detergent solution or components (TSP, commercial detergents)
- Absorbents to clean off gross contamination
- Rags, cloth and paper towels.

B. For containment:
- Tapes, poles, flags for boundary marking of clean, hot, decon areas.
- Tubs, inflatable wading pools for wash solutions
- Plastic sheets, dyking material for major containment
- Plastic sheets for depositing contaminated equipment
- Plastic sheets to create uncontaminated space for changing
- Portable pump to recover contaminated washings.

C. Storage and Transportation of Contaminated Equipment:
- Tags
- Heavy plastic bags, ties, for clothing.

- Impervious containers for contaminated equipment, clothing, used decontaminants, etc.
  (Plastic or lined drums or boxes, plastic garbage cans, etc)
- Drums, tanks for contaminated wash solutions. (eg Tank Truck).

D. Protective Clothing for Decon Assistant:
(Disposable) encapsulating suits, coveralls, hoods, gloves.

E. Replacement Clothing and Footwear.
(Disposable) clothing, coveralls, coats, pants, smocks, boots.

F. Personal Cleaning After Decontamination:
Wash basin, soap, water, towels, nail brushes, first aid.

5.2: Suggested Portable Decon Kit

Kit Container: Lined drums with handles; plastic garbage cans.

Cleaning:
2 Shower heads, with extension pipe, with fittings for fire hose, garden hose, or portable pump discharge line.
2 - Long handled brushes; 2 - hand brushes
Sack of absorbent
Box of rags
Six towels
12 packets - paper towels.
4 bottles - detergent
Packets TSP for TSP solution
Plastic pails, plastic hose.
Portable pump for water supply, recirculation.

Containment:
2 - Inflatable wading pools, 8'dia; foot pump, (connections for inflation from air bottles?)
4 - plastic ground sheets, 12' x 12'
Shovel
100 ft(?) barrier tape, stakes, flags.

Storage and Transport:
6 packages of 5 Heavy plastic bags and ties.
2 - large plastic garbage cans (can use as containers for kit)
Overpack drums (not part of kit)
Packet of tags with strings.
Duct tape, plastic cord

Clothing: Replacement and for Decon Assistant:
6 suits disposable coveralls
6 disposable encaps suits
Disposable jackets, pants, smocks, hoods.
10 sets disposable boots
Disposable gloves

Personal Cleaning:
6 bars soap

3 nail brushes
3 face cloths
6 towels
Container for above

6.0 Testing Procedures: (As page 7 of Draft C-I-L Decontamination Guidelines)

Visual
Wipe Sampling
Cleaning Solution Analysis:
Testing for Permeation:

7.0 Secondary Cleaning and Decontamination of Equipment After Removal:

7.1: On Scene: Preparation for transport to Home Base:

If equipment has been contaminated and primary decontamination may not be fully effective, or if Procedure C above was followed, equipment and clothing is to be properly prepared for safe return to home base. If possible it may be further decontaminated at this stage, to stop deterioration. It is then segregated as to degree of contamination, type of contaminant, type of equipment, etc., packed in appropriate impervious containers, sealed and tagged as to type of contaminant, type of equipment, degree of contamination, known defects, etc. Drums or lined boxes should be used for heavy equipment, eg SCBA and cylinders, vetter bags, etc; heavy plastic bags (doubled if appropriate) for protective or personal clothing, used decontaminants such as rags, paper, leaves or absorbents, etc.

Clothing is to be right-side-out, fastened if convenient, and carefully rolled to minimize contamination of inner surfaces.

Persons carrying out this work must be well protected against contact with the contaminant, and any washings collected.

7.2: At The Home Base Location:

A. General procedure:

1. While wearing appropriate protective equipment (body-covering clothing and goggles as a minimum) plus respiratory protection if needed, carefully remove lesser contaminated equipment from sealed containers.

2. Inspect equipment to determine appropriate secondary cleaning method and solutions required, and relative merits of proceeding with cleaning, or disposing of equipment.

3. Proceed with selected action. If cleaning and recondition selected, reinspect equipment frequently during process to determine effectiveness, and dispose of if inadequate results achieved.

4. Repeat above sequence with successively more contaminated containers.

B. Special Techniques.

(From C-I-L Decontamination Guidelines, Sec. 6.0, page 8).

Techniques:

Dissolution of contaminants
Cleaning with Surfactants
Solidification
Rinsing (repeated)
Disinfectant/Sterilization

C. Decontaminating Solutions for Specific Purposes

- Carbonate and TSP
- Hypochlorite
- Dilute HCl
- Detergent

D. Decontamination vs Disposal

CONTROL OF LIQUIFIED PETROLEUM GAS ESCAPE FROM PIPING, STORAGE & TRANSPORT TANKS

Captain Ronald E. Hague
City of Edmonton Fire Department

The City of Edmonton's Fire Department is located within the nucleus of Western Canada's Petro Chemical Community. The Fire Department has first alarm response responsibility to approximately 576,000 citizens, within an area of 680 square kilometres (270 square miles). In order to meet this mandate, there are 24 strategically placed fire stations, manned by 826 firefighting personnel, with a total department staffing of 945.

The specifically trained Dangerous Goods Response Team consists of 10 fire officers and 27 firefighters. This team responds from a central location, to all incidents involving dangerous goods, as required by the incident commander. This response brings on scene, specialized support equipment for the successful mitigation of incidents involving liquified petroleum gas.

Located within, and adjacent to the City's corporate boundary, are Western Canada's major producers and processors of liquified petroleum gas, to which we provide initial or support response under a mutual aid pact. Their production is distributed by pipeline, rail tank cars, and truck tankers, using the pipeline corridors, railways, and highways which traverse our City.

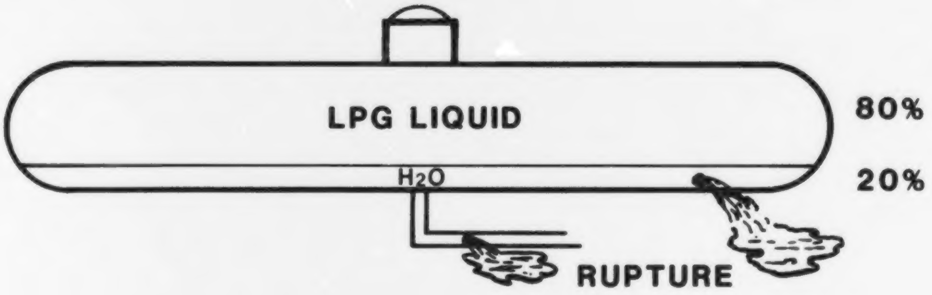
The domestic consumption of propane within the community is wide-spread and diverse, providing energy for permanent and temporary heating, motor vehicles, and recreation. Due to this diversity of consumption, it is not possible to identify and pre-plan remedial action in the event of accidental product release for each site.

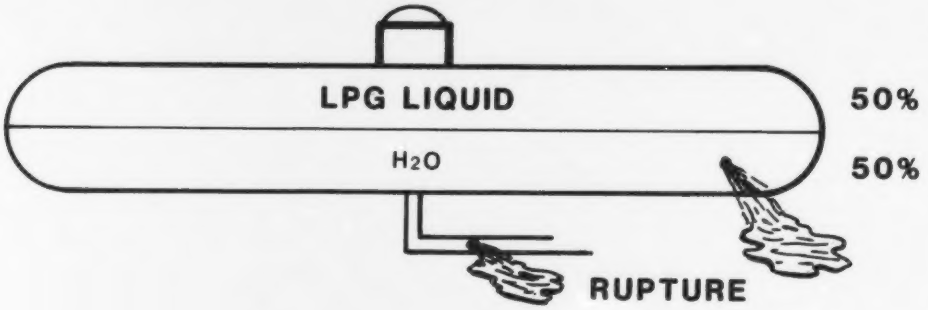
Therefore, the Fire Department was charged with identifying hazards, conditions of product escape, and for the development of procedures which would ensure safe mitigation for all climatic conditions.

The study indicated the majority of incident occurrences would centre around propane tank damage or service fitting failure. Experience and statistics indicated most incidents could occur in populated areas, with the potential of heavy life and property loss. These findings indicated standard fire attack procedures for vapour suppression, and tank stabilization did not always provide a safe and efficient remedial action. Heavy water fog fire streams will furnish additional time for effective evacuation, ignition source isolation or extinguishment, and protection of exposures during flare off procedures. This precipitated the development of procedures using propane filler adaptor fittings in conjunction with a 38 mm fire hose for water injection into LPG tanks. These procedures were tested, evaluated and placed into service in 1981.

The water injection procedure is based upon the scientific principle of specific gravity. The specific gravity of water is 1, propane is 0.59 and isobutane is 0.557. In procedural application, this differential brings about the attitude of LPG floating on the surface of water within the closed pressurized containers.

This procedure is applied to those incidents where liquid product is escaping from the lower 15 to 20% volume area of full tanks or there is product escape from liquid service lines where the flow would not exceed 909 L/min (200 gpm). If the container is only partially filled, the damage location on the tank could naturally be located in a higher volume area and still allow for this procedural application. Note, a 0.75" nozzle flows 973 L/min (214 gpm) at 1656 kPa (240 psi).



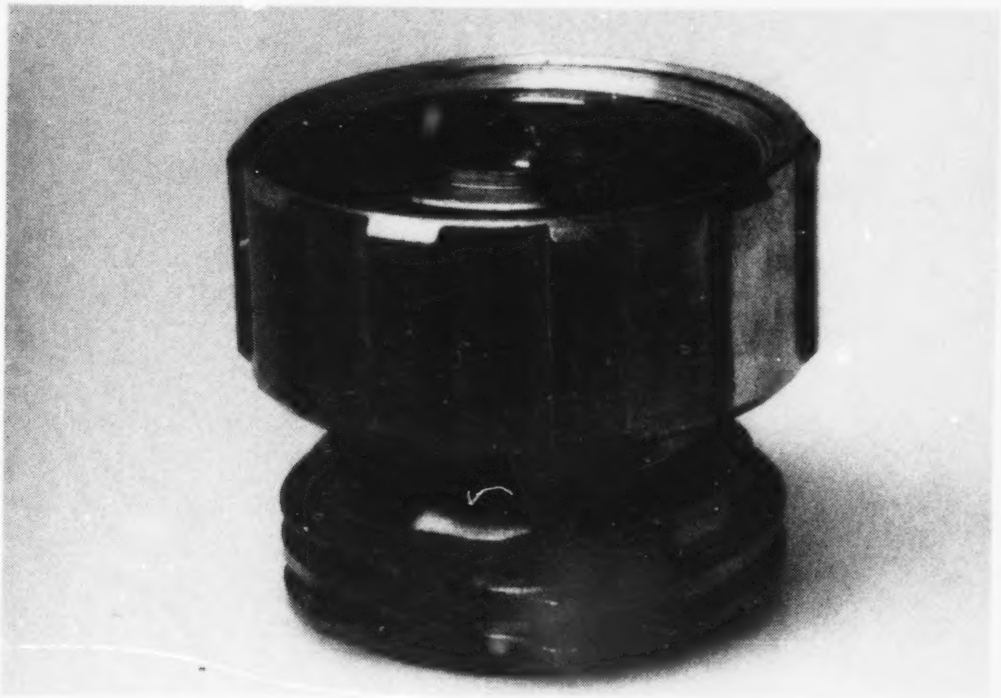


Note: Mitigation Procedure will be explained under Methodology.

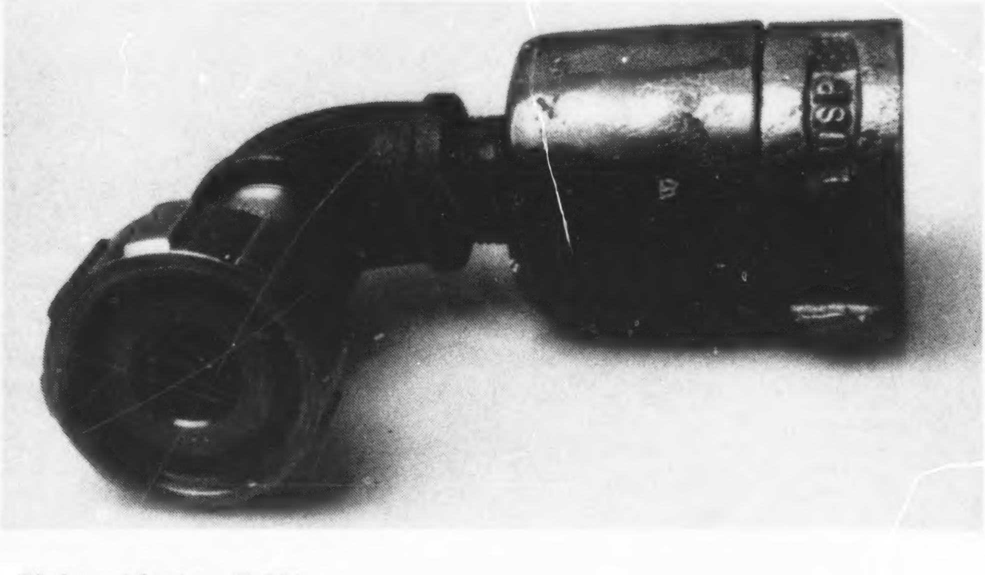
Equipment Requirements:

The equipment requirements for this method of incident control is minimal, for Fire Departments with pumper units capable of 6000 L/min (1250 gpm), provided adequate water supplies or a combination of pumpers capable of supplying desired water volumes are available. The use of master stream appliances with minimal manning is recommended for container cooling, exposure protection and large volume vapour suppression. (Master Stream Appliances flow 1325 to 4731 L/min or 291 to 1040 gpm).

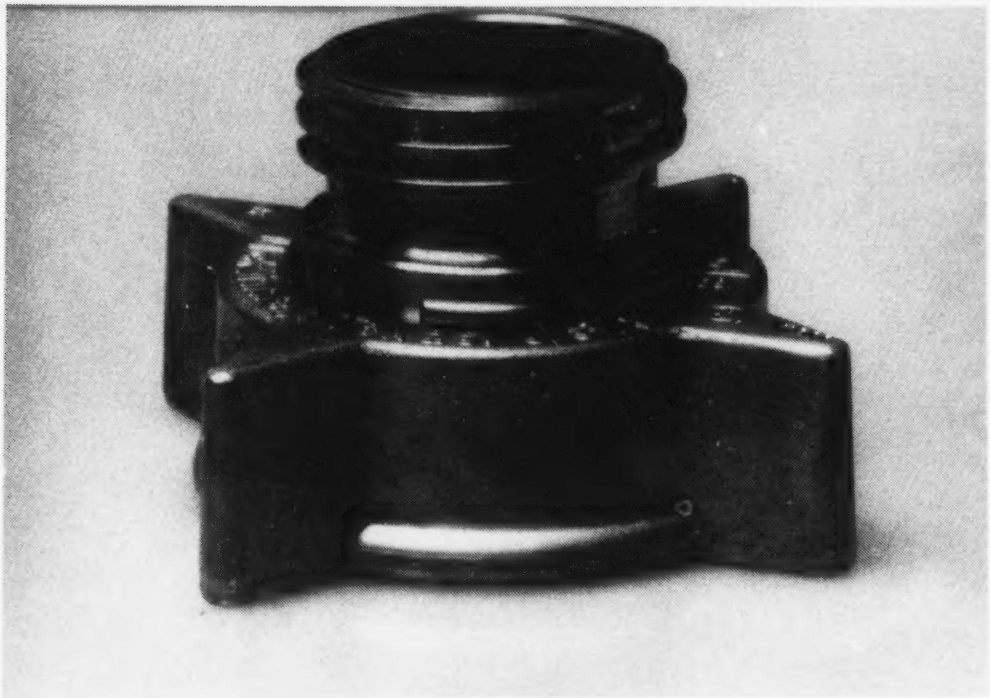
The acquisition of the following LPG Adaptors will be required to evolve this procedure:



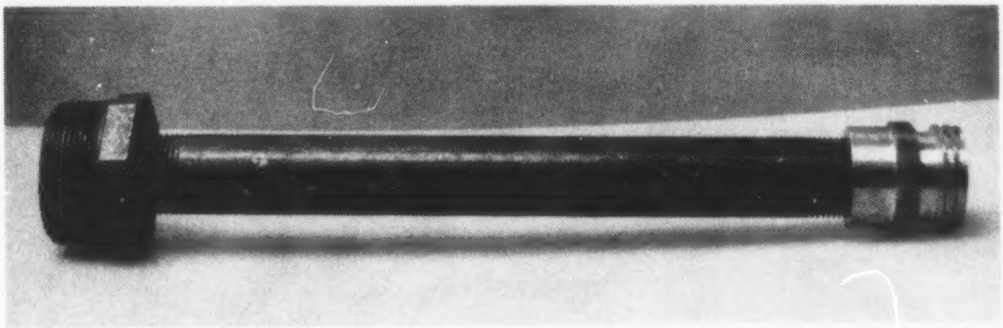
Sherwood Adapter P A 901 B
Description: secondary filler valve adaptor



Fisher Adapter M 111
High Pressure 90 degree Plumbing Elbow
High Pressure nipple
38 mm (1.5") Brass Fire Hose Coupling
Description: water supply adaptor for connection to the vapour filler valve on tanks and cylinders for water injection procedures.



Fisher Filler Adaptor M 611
Description: applied in conjunction with adaptor M 111 to inject water into a Highway L.P.G. tanker via the vapour filler line.



Fisher Filler Adaptor M 214
300 mm (12") Black High Pressure Pipe N.P.T.
50 mm X 25 mm (2" X 1") Bushing N.P.T.
Description: applied in conjunction with M 111 adaptor to inject water into Rail L.P.G. Tankers via the vapour filler valve located in tank car dome.

Methodology for LPG Adaptor Use:

Scenario 1

Incident Generator: Product escaping from a tank filler valve. This is often the result of the filler valves failure to reseal due to foreign material being lodged on the valve seat.

Corrective Action: Using a solid rubber mallet, strike the tank adjacent to the filler valve. This jarring action often seats the valve. The Sherwood LPG Adaptor PA 901 B can be screwed onto the existing filler valve threads. This will stop any discharge of product.

Scenario 2

Incident Generator: Liquid product escaping from the lower surface area of a tank or the liquid service lines, with no fire involvement.

Corrective Action: Approaching from up wind, using large volumes of water fog to disperse vapour cloud, dilute these vapours below their lower explosive limits (approximate 1.8 - 2% LEL in air). Extinguish all sources of ignition within reasonable proximity of vapour cloud exposure. Evacuate affected area up to one kilometre radius. Using four 38 mm fog hose lines for personnel protection, attack tank from upwind. Position personnel as a unified front with fog patterns interlocked pushing the vapour cloud away from the tank. Make connection of filler adaptor M 111 complete with a 38 mm supply line to the tank filler valve. Initiate water supply from pumper and withdraw personnel as a unit. The pump pressure should not exceed 1650 kPa (240 psi) in temperatures above freezing and a pressure of 860 kPa (125 psi) is applicable when the ambient temperature is below freezing (Refer to Table 1). Once the product escape has stopped and water flow is present, normal emergency patching procedures or valve replacement etc can be initiated. Final incident mitigation by product transfer or flaring will be dictated by the presiding circumstances of each incident.

Scenario 3

Incident Generator: Liquid product escaping from the lower surface area of a tank or liquid service line, with fire involvement.

Corrective Action: Approach the incident cautiously, using structures, topography, or equipment for protection, maintaining evaluation as proximity increases. Your evaluation should include "Is the pressure relief valve functioning?". Assess the flame involvement and proximity of flames to their source. Evaluate container integrity; note, tank distortion or the occurrence of paint discolouration, blistering and peeling. These factors will provide information as to the pressure conditions within the tank and the length of time the tank has been fire involved. Containers which have been fire involved will turn blue, indicative of over-heating of the ductile steel. The flame colour will indicate whether the fire is fuelled by high pressure vapour or a liquid source. Dark red or orange indicates a rich liquid fed vapour fire, whereas bright yellow white flame is indicative of a highly pressurized vapour fed fire. This observance will assist in remote evaluation of potential damage, or product source. If circumstances indicate container stability, immediate use of heavy fog streams for cooling of the vapour space is required, including the deflection of flames impinging on the tank. When the fire is pushed away from the tank, and the tank has cooled, pressure within the vapour space will reduce, the high pitched whistle of vapours exiting the relief valve reduce and flame intensity will diminish. When the pressure relief valve reseats due to cooling and pressure reduction, and remains closed for 15 to 20 minutes, the incident is considered controlled. Now, remedial action using water injection or patching procedures can be initiated as the situation dictates. Refer to Scenario 2. If this reduction does not occur but the intensity increases, **IMMEDIATE EVACUATION FOR ONE KILOMETRE RADIUS IS IMPERATIVE DUE TO IMPENDING MAJOR CONTAINER FAILURE**. Major container failure and the resulting BLEVE is often precipitated by an increase in flame brightness and a high pitched noise factor indicative of increased container pressurization.

Previous Incident History

Incident 1 This incident will demonstrate the need for training and the development of emergency response procedures. The incident occurred in 1980 at a construction site where an LPG tank mounted on a trailer was providing a temporary fuel source for Herman Nelson heaters. The temperature was -10° C. The tank was being refuelled without the shut down of the vaporizer or heaters. When the tank was filled and the supply hose removed, the filler valve failed to seat allowing liquified propane gas to flow. This liquid vaporized, found a source of ignition and resulted in an intense fire of the valve bonnet area with flames impinging on the supply line leading to the vaporizer.

The first due in pumper laid-in two 90 mm supply lines and immediately started cooling procedures by spraying down the entire tank. This action, started to warm the tank and its contents. The radiated heat of the fire along with the warming process increased tank pressure and fire intensity. The fire streams were subsequently applied to the fire involved vapour space, pushing the heat and flame away from the tank. This method of control was maintained for 3.5 hours while product was consumed by fire. At this time, the tank suppliers representative broke the valving from the tank in an attempt to have the excess flow valve activate. This action was unsuccessful and when the product content reached a level of approximately 10%, the fire was extinguished using dry chemical extinguishers. The tank was then transported by the supplier to a remote area away from the city. The exposures to this incident were of commercial and residential occupancy.

This incident could have been totally avoided using proper filling procedures and the application of a secondary filler valve adaptor.

Incident II This incident involved a tank releasing liquid at a construction site in a developed residential community. The temperature was -30° C with no fire involvement. This incident evolved by the dislocation of the liquid supply valve and failure of the excess flow valve to activate. Responding emergency crews applied vapour cloud dispersion using intrinsically safe fans with capacities of 666 m^3/min until the product had totally dissipated.

This incident could have been rendered safe by application of water injection and the subsequent replacement of the valve assembly.

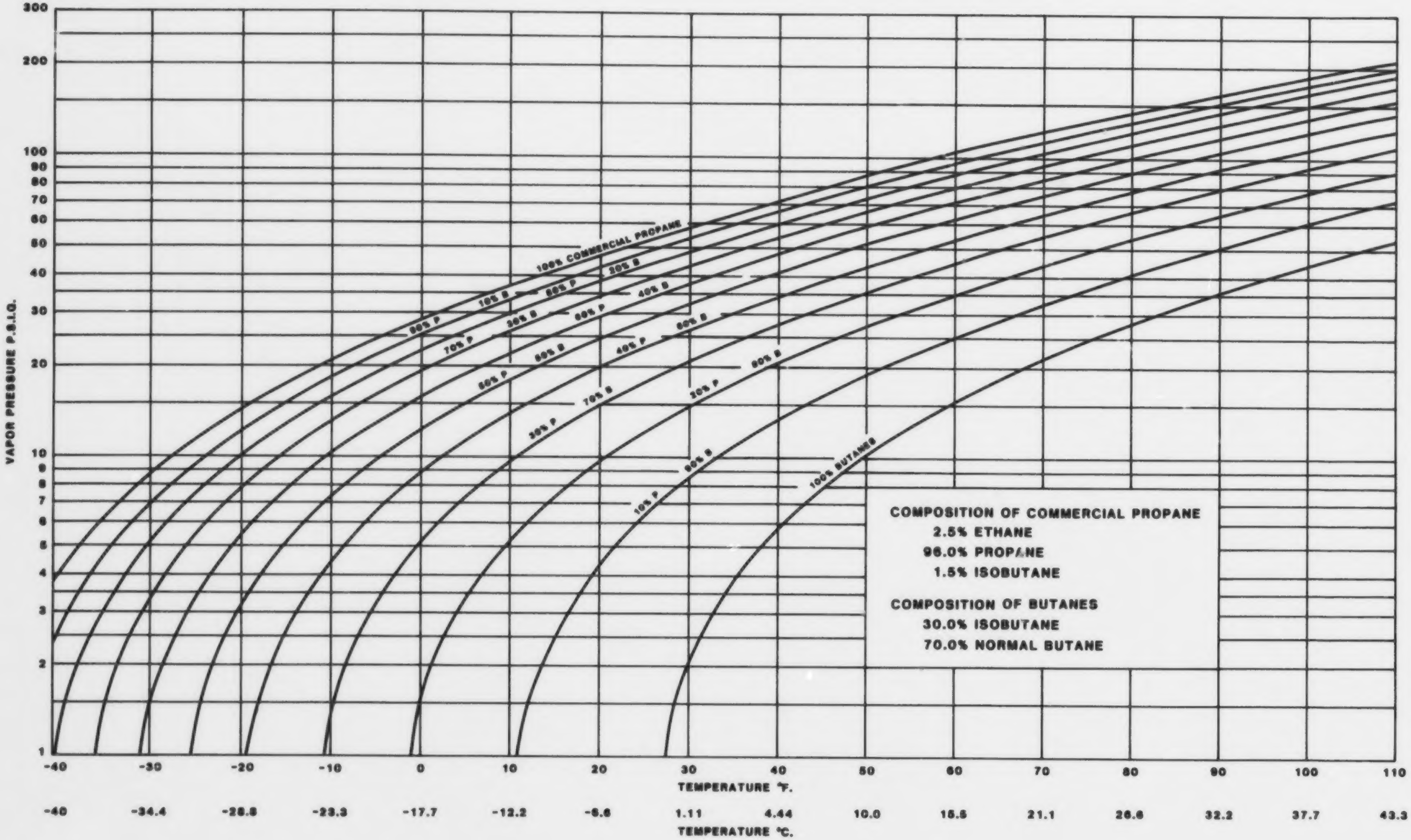
Incident III Incident III occurred shortly after the responding officer had received procedural training for LPG incidents. At the time of arrival, the tank was involved in flame, the pressure relief valve had not activated and paint discolouration in the vapour space was evident. Initial attack consisted of cooling the vapour space of the tank.

Four 38 mm fog lines were advanced as a unified front pushing the fire away from the tank exposing the liquid control valve and the broken off supply line. The officer then closed the liquid control valve rendering the incident safe. This incident occurred at a school construction site within a residential community. In the event the valve would have been inoperable, application of the water injection procedure would have led to a successful mitigation.

Incident IV This incident involved a tank mounted on a two wheel trailer which had been loaded on a flat bed truck. The tank had a 250 mm riser threaded into the tank bottom with a control valve located at the opposite end of the riser. The tank was filled to the 65% capacity, ignoring the legal 5% limit for transportation. Improper securing allowed the trailer to move during transport resulting in the collapse of the hitch support . Due to this collapse, the valve and riser struck the truck bed, resulting in a partial break in the riser adjacent to the tank. The Fire Department responded to this liquid release using water fog for vapour suppression. Water injection incorporating the M 111 adapter and a 38 mm supply line was initiated, resulting in a water discharge from the broken riser. The riser was then removed, a brass bushing and cap installed, rendering the incident safe.

TABLE 1

VAPOR PRESSURES OF
NORMAL BUTANE-ISOBUTANE-PROPANE MIXTURES



Review of Personal Protective Equipment

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ABSTRACT

Personal protective equipment is very important in spill situations because the user faces a multitude of safety and health concerns that could result in serious injury or illness. The multiple hazards at spill sites, especially the unknown hazards, distinguish spills from occupational situations involving hazardous materials. A variety of specialized protective equipment may be required by spill responders including respiratory protection devices, gas-tight suits, protective clothing, boots and gloves.

Respiratory protection equipment usually consists of a positive-pressure SCBA(self-contained breathing apparatus). Air-purifying respirators have limited application at spill scenes and are not recommended for use other than in long-term cleanups where hazards are fully understood. Totally-encapsulating or gas-tight suits are used to prevent toxicant entry via skin. The state-of-the-art of such suits is rapidly improving and new suit materials promise to provide multiple-toxicant protection. Protective clothing is required for situations where contact with the material is undesirable but penetration of vapour though the skin is not an important consideration. Chemical compatibility and user-comfort are very important considerations when selecting from the many types of clothing available. The selection of goggles and face-shields is also done on the basis of these two criteria, but the use of face-shields is not recommended in cases where splashing can occur at chest level, because these devices can direct splashed material to the facial area instead of protecting it.

Response to chemical spills requires a comprehensive program to protect employees from injury. The program should include medical testing, training, retraining and practice and equipment acquisition, maintenance, upgrade and replacement. This program should be based on a carefully-developed policy regarding spill-site entry procedures and minimum training/equipment requirements.

INTRODUCTION

Spill responders face a multitude of health and safety concerns. Such hazards include:

- exposure to unknown chemicals in unknown quantities,
- fire and explosion,
- potential entrapment in wreckage,
- falls,
- oxygen deficiency,
- heat stress,

- cold exposure, and
- failure of safety equipment

These hazards are accentuated by the unknown nature of the spill site and the random nature of spills. The multiple hazards of spill sites distinguish such incidents from occupational situations involving hazardous materials. Those in spill response cannot always predict which chemicals they will encounter. Responders entering a site are not only subject to the hazards of chemical exposure, but also to the dangers posed by the unknown and disorderly physical environment of a spill site. There is also a notable lack of standards and guidelines for the selection and operation of spill emergency equipment.

Preventing exposure to toxic chemicals is a primary concern at spill sites. Substances can enter the unprotected body by inhalation, skin absorption and ingestion. Ingestion can occur by transferring absorbed contaminant during eating, smoking or by other forms of contact with the mouth. Chemical exposures are generally divided into two categories: acute and chronic. Acute exposures are short-term contact with the contaminant, for example one-hour or one day exposures. The term "chronic" implies long-term exposure, say for weeks or years. In spill situations the concern is for acute exposure.

The most common categories of protection equipment necessary for spill response are clothing and respirators. Totally-encapsulated or gas-tight suits are used when the contaminant is unknown or when a skin-penetrating or skin-attacking chemical is present. The SCBA or self-contained breathing apparatus is the most commonly used form of respiratory protection in the initial phases of a spill and provides the highest protection against the inhalation of chemical contaminants. The use of equipment at a spill scene is summarized in Table 1. The levels illustrated here are commonly accepted among spill response organizations including Environment Canada, United States Environmental Protection Agency and the United States Coast Guard.

Level A is the first-response or entry level. The SCBA and totally-encapsulated suit are used to protect against high or unknown levels of chemicals. Chemical substances that permeate or otherwise attack the skin may be present and the totally-encapsulated suit must protect against these. Level B involves the use of the SCBA with standard chemical-protection clothing. Level B gear is used to enter a situation where it is known that no skin-penetrating or damaging chemicals are present, or where high levels of contaminant may be present that a standard air-purifying device would not protect against. The clothing constitutes a variety of acceptable options, but usually consists of coveralls or rain-type gear and rubber boots. Gloves are used throughout the first three protection levels.

Level C includes respirators and standard clothing, which most typically consists of liquid-repellant coveralls. This level of response is very commonly used by clean-up crews when the situation has stabilized and concentrations are known and are not likely to rise above the capability of the respirator. No skin-penetrating materials are present. Level D is a standard

TABLE 1 LEVELS OF PROTECTION USED AT SPILLS

LEVEL	SITUATION	PROTECTIVE EQUIPMENT
A	ENTRY INTO UNKNOWN OR SKIN-PERMEATING CHEMICAL PRESENT	SCBA & GAS-TIGHT SUIT
B	HIGH CONCENTRATIONS AND NO SKIN-ATTACKING CHEMICALS PRESENT	SCBA & STANDARD CLOTHING
C	KNOWN CONCENTRATIONS OF NON-PERCUTANEOUS CHEMICALS - MOST CLEANUPS	RESPIRATOR & STANDARD CLOTHING
D	SITUATION FULLY UNDER CONTROL AND CHEMICALS BELOW DANGER LEVELS	STREET CLOTHING

level involving no respiratory protection and little special clothing. Some organizations may specify coveralls or boots for this level to minimize contaminant spread. Level D is applicable to spills where there are no air-borne contaminants of concern and where the likelihood of harm by contact with the spilled material is minimal.

THE SPILL SITUATION

The most important consideration for protection equipment selection is the target chemical. The nature of spills becomes an important topic because one cannot be prepared for all spills but can be prepared for the most frequent spills.

A national data base has been in existence in Canada for a number of years and is useful in assessing priorities.[1,2] Table 2 is a list of the most common chemicals spilled, their frequency and volume over the ten-year period of 1974 to 1984. Only 35 materials have been spilled in over 10 instances and 105 materials have been spilled more than 3 times. The list shows us that about 5% of the incidents are single or one-time incidents with a low probability of repeat. About 90% of the incidents are spills of common industrial materials. Fifty substances account for about 90% of the spills and 100 substances for about 95% of the spills.

Table 3 is a summary of the protection requirements necessary for the materials that have been spilled twice or more during the ten year survey period. The assessments are given in terms of whether SCBA's or encapsulated suits are required or not. Some listings are rated as "possible" for normal cleanup, this means that sufficient concentration of material may remain to require the use of the SCBA over the air-purifying respirator. Use of Tables 1 and 2 will enable the potential spill responder to be prepared for most of the potential chemical spills, even without specific knowledge of the production and transportation of material in that region.

Selection of Respiratory Protection Equipment

Selection of respiratory protection equipment in the workplace has been the topic of several well-known references.[3,4,5] Selection of this equipment for spill situations has been described in two references.[6,7] The differences between normal workplace respirator selection and selection for spills hinges on the certainty with which both the substances present and their concentrations, are known. In spill situations maximum protection must often be used because of the possible presence of high chemical concentrations.

Respiratory protective devices consist of a face-piece connected to either an air-source or an air-purifying device. There is a wide variety of devices on the market, some of these are listed in Table 4. This table also lists a protection factor which is the ratio of the concentration of the contaminant outside the facepiece versus the concentration inside the facepiece. The protection factors presented in the table represent an average value for a large number of individuals. Such values can be much lower in the case of an individual with a

Table 2 SPILL OF CHEMICALS 1974-1984

CHEMICAL	NUMBER OF SPILLS	VOLUME(t)
Polychlorinated biphenyls	334	89
Sulphuric acid	155	13362
Hydrochloric acid	123	3335
Ammonia,anhydrous	107	466
Sodium hydroxide	92	8225
Sulphur	68	69720
Ammonium nitrate	63	4237
Fenitrothion	49	100
Nitric acid	40	139
2,4-D	37	129
Chlorine	36	120
Ethylene glycol	31	593
Potassium chloride (potash)	31	11836
Vinyl chloride	31	183
Styrene	24	5001
Sodium chlorate	23	7676
Calcium chloride	20	3678
Pentachlorophenol	19	109
Methanol	18	734
Calcium hydroxide	17	360
Phosphorus	16	45
Sulphur dioxide	16	89
Ammonium hydroxide	15	127
Asbestos	15	310
Xylenes	14	46
Toluene	13	105
Aminocarb	12	55
Benzene	12	13
Calcium oxide	12	530
Phosphoric acid	12	36
Mercury	11	19
Sodium hypochlorite	11	58
Phenol	10	14
Perchloroethylene	10	15
Formaldehyde	10	41
Formaldehyde	10	41
Perchloroethylene	10	15
Phenol	10	14
Acetic acid	9	73
Aluminum sulfate	9	122
Trifluralin	9	4
Acetic anhydride	8	1
Ammonium sulfate	8	261
Ferric chloride	8	1004
Phosphamidon	8	15
Vinyl acetate	8	7
Chromic acid	7	8
Cyanides	7	2
Hydogen peroxide	7	0.5
Malathion	7	0.3

Table 2 ctd.

Chemical	Numbers of Spills	Volume (t)
Toluene diisocyanate	7	2
Ethyl mercaptan	6	0.01
Ammonium phosphate	5	144
Copper sulfate	5	22
Ferric oxide	5	22
Hexane	5	8
Hydrofluoric acid	5	0.7
Lignin sulfonate	5	181
MCPA	5	1
Oxygen,liquified	5	24
Acetone	4	9
Calcium hypochlorite	4	17
Carbofuran	4	0.05
Diazinon	4	0.2
Ethyl benzene	4	0.8
Isopropanol	4	9
Methyl ethyl ketone	4	7
Methylene chloride	4	6
Potassium permanganate	4	9
Sodium sulfite	4	29
Tetraethyl lead	4	71
Trichloroethane	4	0.8
Aluminum phosphate	3	8
Calcium phosphate	3	103
Cesium 137	3	0.000003
Diallate	3	0.08
Ethanol	3	50
Ethyl acrylate	3	1
Flamprop-methyl	3	0.2
Hydrazine	3	4
Methyl methacrylate	3	3
Naphthalene	3	6
Nitrogen	3	1
Nitrogen dioxide	3	0.001
Phthalic anhydride	3	7
Picloram	3	0.5
Sodium carbonate	3	25
Sodium cyanide	3	82
Sulphur chloride	3	3
Trichlorfon	3	2
Uranyl nitrate	3	0.2
Zinc oxide	3	54
Zinc sulphate	3	68

TABLE 3 REQUIREMENTS FOR PROTECTIVE EQUIPMENT

	SCBA's		**ENCAPSULATED SUITS**	
	EXTREME SITUATIONS	**NORMAL CLEANUP**	**EXTREME OR ENTRY**	**NORMAL CLEANUP**
Acetic acid	YES	POSSIBLE	YES	NO
Acetic anhydride	YES	POSSIBLE	YES	NO
Acetone	YES	POSSIBLE	YES	NO
Aldrin	YES	NO	YES	NO
Aluminum phosphate	YES	NO	NO	NO
Aluminum sulfate	YES	NO	NO	NO
Aminocarb	YES	POSSIBLE	YES	NO
Ammonia,anhydrous	YES	YES	YES	NO
Ammonium hydroxide	YES	POSSIBLE	YES	NO
Ammonium nitrate	YES	NO	NO	NO
Ammonium phosphate	YES	NO	NO	NO
Ammonium sulfate	YES	NO	NO	NO
Asbestos	YES	NO	NO	NO
Atrazine	YES	NO	YES	NO
Benzene	YES	POSSIBLE	YES	NO
Benzoic acid	YES	NO	YES	NO
Calcium chloride	YES	NO	NO	NO
Calcium hydroxide	YES	NO	NO	NO
Calcium hypochlorite	YES	NO	YES	NO
Calcium oxide	YES	NO	NO	NO
Calcium phosphate	YES	NO	NO	NO
Carbaryl	YES	NO	YES	NO
Carbofuran	YES	NO	YES	NO
Cesium 137	YES	NO	NO	NO
Chlordane	YES	NO	YES	NO
Chlorine	YES	YES	YES	POSSIBLE
Chlorine dioxide	YES	POSSIBLE	YES	POSSIBLE
Chromic acid	YES	NO	YES	NO
Copper sulfate	YES	NO	NO	NO
Cresols	YES	NO	YES	NO
Cyanides	YES	NO	YES	NO
Diallate	YES	NO	YES	NO
Diazinon	YES	NO	YES	NO
Dicamba	YES	NO	YES	NO
Diethylamine	YES	NO	YES	NO
Dimethyl amine	YES	NO	YES	NO
Dinitroamine	YES	NO	YES	NO
Diquat	YES	NO	YES	NO
Ethanol	YES	NO	NO	NO
Ethyl acrylate	YES	NO	YES	NO
Ethyl benzene	YES	NO	YES	NO
Ethyl chloride	YES	NO	YES	NO
Ethyl mercaptan	YES	YES	YES	NO

TABLE 3 continued

	REQUIREMENTS FOR PROTECTIVE EQUIPMENT			
	SCBA's		ENCAPSULATED SUITS	
	EXTREME SITUATIONS	NORMAL CLEANUP	EXTREME OR ENTRY	NORMAL CLEANUP
Ethylene	YES	NO	NO	NO
Ethylene glycol	YES	NO	NO	NO
Fenitrothion	YES	NO	YES	NO
Ferric chloride	YES	NO	NO	NO
Ferric hydroxide	YES	NO	NO	NO
Ferric oxide	NO	NO	NO	NO
Flamprop-methyl	YES	NO	YES	NO
Formaldehyde	YES	POSSIBLE	YES	NO
Heavy water	NO	NO	NO	NO
Hexane	YES	NO	NO	NO
Hydogen peroxide	YES	NO	YES	NO
Hydrazine	YES	NO	YES	NO
Hydrochloric acid	YES	POSSIBLE	YES	POSSIBLE
Hydrofluoric acid	YES	POSSIBLE	YES	POSSIBLE
Isopropanol	YES	NO	NO	NO
Lead oxide	YES	NO	NO	NO
Lignin sulfonate	YES	NO	NO	NO
Malathion	YES	NO	YES	NO
MCPA	YES	NO	YES	NO
Mercury	YES	NO	YES	NO
Methanol	YES	NO	YES	NO
Methyl chloride	YES	NO	YES	NO
Methyl ethyl ketone	YES	NO	YES	NO
Methyl methacrylate	YES	NO	YES	NO
Methylene chloride	YES	NO	YES	NO
Naphthalene	YES	NO	YES	NO
Nitric acid	YES	POSSIBLE	YES	POSSIBLE
Nitrogen	YES	NO	NO	NO
Nitrogen dioxide	YES	POSSIBLE	YES	NO
Nonylphenol	NO	NO	NO	NO
Oxygen,liquified	YES	NO	NO	NO
Paraquat	YES	NO	YES	NO
Pentachlorophenol	YES	NO	YES	NO
Perchloroethylene	YES	NO	YES	NO
Phenol	YES	NO	YES	NO
Phenolsulfonic acid	YES	NO	YES	NO
Phosphamidon	YES	NO	YES	NO
Phosphoric acid	YES	NO	YES	NO
Phosphorus	YES	NO	YES	NO
Phthalic anhydride	YES	NO	YES	NO
Picloram	YES	NO	YES	NO
Polychlorinated biphenyls	YES	NO	YES	NO
Potassium chloride	POSSIBLE	NO	NO	NO

TABLE 3 continued	REQUIREMENTS FOR PROTECTIVE EQUIPMENT			
	SCBA's		ENCAPSULATED SUITS	
	EXTREME SITUATIONS	NORMAL CLEANUP	EXTREME OR ENTRY	NORMAL CLEANUP
Potassium hydroxide	POSSIBLE	NO	NO	NO
Potassium permanganate	YES	NO	NO	NO
Propylene oxide	YES	NO	YES	NO
Pyridine	YES	NO	YES	NO
Sodium carbonate	POSSIBLE	NO	NO	NO
Sodium chlorate	POSSIBLE	NO	NO	NO
Sodium chloride	NO	NO	NO	NO
Sodium cyanide	YES	NO	YES	NO
Sodium dithionite	YES	NO	YES	NO
Sodium hydrosulfide	YES	NO	YES	NO
Sodium hydroxide	YES	NO	YES	NO
Sodium hypochlorite	YES	NO	YES	NO
Sodium sulfite	NO	NO	NO	NO
Styrene	YES	NO	YES	NO
Sulfuryl chloride	YES	NO	YES	NO
Sulphur	YES	NO	NO	NO
Sulphur chloride	YES	NO	YES	NO
Sulphur dioxide	YES	NO	YES	NO
Sulphuric acid	YES	NO	YES	NO
Terphenyl	YES	NO	YES	NO
Tetraethyl lead	YES	POSSIBLE	YES	POSSIBLE
Titanium dioxide	NO	NO	NO	NO
Toluene	YES	NO	YES	NO
Toluene 2,4-diamine	YES	NO	YES	NO
Toluene diisocyanate	YES	NO	YES	NO
Trichlorfon	YES	NO	YES	NO
Trichloroethane	YES	NO	YES	NO
Trifluralin	YES	NO	YES	NO
Uranyl nitrate	YES	NO	NO	NO
Vinyl acetate	YES	NO	YES	NO
Vinyl chloride	YES	POSSIBLE	YES	NO
Xylenes	YES	NO	YES	NO
Zinc oxide	NO	NO	NO	NO
Zinc sulphate	NO	NO	NO	NO
2,4-D	YES	NO	YES	NO
2,4,5-T	YES	NO	YES	NO

TABLE 4 RESPIRATORY PROTECTION EQUIPMENT AND ASSOCIATED PROTECTION FACTORS

RESPIRATOR	PROTECTION FACTOR
AIR-PURIFYING - PARTICULATE	
SINGLE-USE DUST MASK	5
QUARTER-MASK	5
HALF-MASK DUST MASK	10
FULL FACEPIECE MASK	50
POWERED DUST MASK	1000
AIR-PURIFYING - GAS REMOVING	
HALF-MASK	10
FULL FACEPIECE	50
SUPPLIED AIR RESPIRATORS	
DEMAND HALF-MASK	10
DEMAND FULL FACEPIECE	50
PRESSURE-DEMAND HALF MASK	1000
PRESSURE-DEMAND FULL FACEPIECE	2000
CONTINUOUS FLOW HELMET OR SUIT	2000
SCBA's	
OPEN-CIRCUIT DEMAND	50
OPEN-CIRCUIT PRESSURE DEMAND	10,000
CLOSED-CIRCUIT, OXYGEN TANK-TYPE (ALL FULL FACEPIECE)	50

poor face-piece fit. Beards, for example, can cause leakage around a face-piece, reducing the protection factor by as much as a factor of 10.

Protection factors are important criteria for the selection of respiratory protection equipment. The protection factor must be sufficiently high to reduce the contaminant to an acceptable level inside the facepiece. This acceptable level is usually taken as the TLV or Threshold Limit Value. Table 5 lists the TLV values for the commonly-spilled materials. These data are used in the following manner. Suppose we had a spill of a substance with a TLV of 5 ppm and by our calculations, the concentration at the spill scene could rise as high as 5000 ppm. We would require a respirator with a protection factor of at least 1000. If we wanted a safety factor of 2, we would need a protection factor of 2000. Because pressure-demand SCBA's have a protection factor of about 10,000, they represent the ultimate in safety and are generally used at spill scenes because the exact substance and amount is never known for certain until investigations have been made.

Air-purifying respirators have limitations on the concentration which they can handle or absorb. The top level at which an air-purifying respirator is useful is at the IDLH or the "immediately dangerous to life and health" level. This is also the level at which a chemical can cause severe damage. The IDLH value represents the value at which one must switch from a air-purifying respirator to one offering more protection, or escape from the environment. Table 5 lists the IDLH values for commonly-spilled chemicals.

To simplify the selection process for respiratory protection at a spill scene, one can set the follow two rules;

- for entry into an unknown situation or where unknown or high levels of a toxic chemical are used, the SCBA should be used,

- where the situation is stable and where the levels of chemicals are below the IDLH and have a very low possibility of rising, the air-purifying respirator can be used. In both cases, the selection should be verified by making measurements and calculating concentrations inside the facepiece.

Clothing Selection

Clothing, gloves, goggles, boots and other such items are required to prevent contact of the chemical with the skin or eyes. Table 6 summarizes the use of these protection devices. In the case of vapours which can be absorbed through the skin, gas-tight protection is required. In the case of chemicals that are corrosive or absorbed as liquids through the skin, protection is required to prevent contact with the substance. Some chemicals pose both dangers.

Chemicals can gain access to the wearer or can affect clothing material in three ways:

1. Degradation: This is the deterioration of clothing material caused by the action of the chemical. Degradation may change bulk properties such as tensile strength or may result in the dissolution of small areas of the material. In previous

TABLE 5 **THRESHOLD CONCERN VALUES FOR FREQUENTLY SPILLED CHEMICALS**

CHEMICAL	TLV	IDLH	CHEMICAL	TLV	IDLH
Acetic acid	10	1000	Methyl chloride	50	
Acetic anhydride	5	1000	Methyl ethyl ketone	200	
Acetone	750	20000	Methyl methacrylate	100	4000
Aldrin	0.25m		Methylene chloride	50	
Aluminum phosphate	2mg		Naphthalene	10	500
Aluminum sulfate	2mg		Nitric acid	2	100
Ammonia	20	500	Nitrogen dioxide	3	50
Asbestos	o.5-2f/cc		Paraquat	0.1m	1.5m
Carbaryl	5m	600m	Pentachlorophenol	0.5s	150m
Carbofuran	0.1m		Perchloroethylene	50	
Chlordane	0.5ms	500m	Phenol	5s	250
Chlorine	1	30	Phosphoric acid	1m	
Chlorine dioxide	0.1	10	Phosphorus	0.1	
Chromic acid	0.5mg	30m	Phthalic anhydride	1	10000
Copper sulphate	1mg		Picloram	10	
Cresol	5s	250	Polychorobiphenyls	1s	
Cyanides	5mgs	50m	Potassium hydroxide	2m	
Diazinon	0.1ms		Propylene oxide	20	2000
Diethylamine	10	2000	Pyridine	5	3600
Dimethylamine	10	2000	Sodium cyanide	5mgs	50mg
Diquat	0.5m		Sodium hydroxide	2m	250m
Ethanol	1000		Styrene	50s	5000
Ethyl acrylate	5	2000	Sulphur dioxide	2	100
Ethyl benzene	100	2000	Sulphuric acid	1m	80m
Ethyl chloride	1000	20000	Terphenyls	0.5	3500m
Ethyl mercaptan	0.5		Tetraethyl lead	0.1mgs	40m
Ethylene	a		Titanium dioxide	10	
Ethylene glycol	50	80	Toluene	100	2000
Ferric chloride	1mg		Toluene diisocyanate	0.005	10
Ferric hydroxide	1mg		Trichloroethane	10s	
Ferric oxide	1mg		Uranyl nitrate	0.2mg	30m
Formaldehyde	1		Vinyl acetate	10	
Hexane	50-500	5000	Vinyl chloride	5	
Hydrazine	0.1s		Xylene	100	1000
Hydrogen peroxide	1	75	Zinc oxide	5m	
Hydrogen Sulphide	10	300	2,4 -D	10m	
Hydrochloric acid	5	100	2,4,5-T	10m	
Hydrofluoric acid	3	30			
Isopropanol	500	12000			
Lead oxide	0.15mg				
Malathion	10ms	5000m			
Mercury	0.05ms	28m			
Methanol	200s	25000			

NOTES ALL VALUES IN PPM EXCEPT WHERE NOTED

m - designates value in mg/m3

f/cc - designates value in fibres per cc

g - indicates a generic value used

s- indicates that the value is for skin contact

TABLE 6 CLOTHING USED FOR SPILL EMERGENCIES

TYPE OR ACCESSORY	DESCRIPTION	USE protects against:
FULL BODY PROTECTION ITEMS		
fully-encapsulating suit	one-piece gas tight suit	most hazards
non-encapsulating suit	not gas-tight	splashes
fire-fighters gear	bunker gear including pants	splashes, heat
proximity garment	heat-resistant garment	heat and flame
TORSO PROTECTION ITEMS		
aprons	aprons of resistant material	splashes
coats	bunker or rain coats	splashes,spray
bib overalls	standard or special material	splashes
overalls	standard or special material	splashes
floatation coat or overalls	floatation material built in	drowning
HEAD PROTECTION ITEMS		
hard hat	standard hard hat	blows,projectiles
helmet liner		cold
hood	liquid-tight hood	contact
EYE AND FACE PROTECTION ITEMS		
face shield	plastic semi-circle	projectiles
splash hood	liquid tight hood	splashes
safety glasses		projectiles
goggles	standard	splashes
goggles, gas-tight		chemicals
EAR PROTECTION ITEMS		
ear plugs		noise
headphones	with communication	noise
ARM AND HAND PROTECTION		
gloves	standard and chemical	chemicals
sleevlets or armlets		splashes
FOOT PROTECTION		
boots	standard or chemical	chemical contact
disposable shoe covers		contact
OTHER ITEMS		
safety harness		falls
life preserver or belt	floation device	drowning
life-line		high-hazard areas

years, the lack of standards for the measurement of other types of chemical intrusion meant that most data were for degradation. Many different measurements were known as "chemical compatibility". As will be shown later, degradation data, although important, are not usually as crucial as permeation data.

2. Permeation: This is the process by which liquid or gaseous chemical moves through clothing material on a molecular basis. It is the most important indicator of the usefulness of a particular clothing material. Some chemicals can pass through clothing material in only a few seconds by permeation. If these chemicals are toxic, then the clothing material is not useful for chemical protection.

3. Penetration: Penetration is the flow of the liquid or gaseous chemical via closures, seams, pin holes or other similar types of openings. Penetration does not pertain to the type of material selected, although certain types of materials are more or less resistant to puncture mechanisms (eg., abrasion, pin-holing) depending on how the clothing is used or abused.

Permeation is the most important of the entry mechanisms in terms of spill response. It is chemical dependent and often variable with a number of conditions including material thickness, temperature and the presence of other solvents. It has been found for example, that mixtures of chemicals can sometimes penetrate the clothing material much faster than any of the substances by themselves.

Existing data on permeation, for the most part, is measured using the ASTM (American Society for Testing and Materials) procedure.[8,9] This prescribes the use of a standard test cell consisting of two spherical halves. The clothing material forms the divider between these two halves. The challenge liquid is placed on one side, with air in the other side. The air is monitored for the presence of the chemical. Breakthrough is said to occur when the chemical can be measured in the air space. As the clothing material is completely immersed in the challenge liquid, the test does provide a conservative measure.

Permeation data for commonly spilled chemicals through common clothing material are presented in Table 7. Data are compiled from the American Conference of Industrial Hygienists collection and from two data bases.[10,11,12] The clothing materials represented here are those commonly-used for totally-encapsulated suits or gloves. In both cases permeation data is very important for selection. Permeation times of less than 30 minutes imply that the material has little application to spills as this is the usual time spent in an encapsulated suit. In some cases, however, there is no material with a long permeation time and the best would be used.

Specific permeation data on the clothing material actually used in the manufacture should be obtained whenever possible. There exist, as noted before, large variances in permeation times, even with similar, but not identical materials. Table 8 shows such variances in the case of butyl rubber, natural rubber and neoprene for the chemical, benzene. Much of the variance illustrated here is due to the thickness of the material. The

TABLE 7 **PENETRATION TIME INTO CLOTHING MATERIALS (min)**

CHEMICAL	**BETEX**	**BUTYL**	**CPE**	**RUBBER**	**NEOPRENE**	**NITPVC**	**NITRILE**	**PVC**	**VITON**
Acetic acid	>360	180	180	120	360	360	360	180	120
Acetic anhydride	>360	>240	60	3	210			4	
Aminocarb									
Ammonia,anhydrous	>360		105						
Ammonium hydroxide	>360	>480		120	360	180	360	180	>60
Ammonium nitrate	>360								
Benzene	15	30V	20	3V	12V	15V	15V	1V	9V
Chlorine	>360	>480	>180	>480	>480		>480	30	>480
Chromic acid	100	>480		70	75	360	360	360	
Cyanides	>360			480	480		480	480	
Ethyl mercaptan	15								
Ethylene glycol	>360			360	360	360	360	360	
Fenitrothion									
Formaldehyde	>360	>480	>180	60	120	30	>360	70V	>480
Hexane	15	15V	180	5	50V	90	360	30	>480
Hydrogen peroxide	>360			>480	6		>360	>360	
Hydrochloric acid	300	>480	>180	360	>360	200	360	360	>480
Hydrofluoric acid	>480	>480	66	150V	360	65	120V	360	>480
Malathion									
MCPA									
Mercury	>360								
Methanol	100	>480	>180	15	10	180V	180V	2	60
Nitric acid	>360	>480		360	150	270	100V	240	60
Pentachlorophenol					6		>360	180	>480
Perchloroethylene	10								
Phenol	>360	>480	190	60	180	120	60	20V	>480
Phosphamidon									
Phosphoric acid	>360			>360	>360	>360	>360	>360	
Phosphorus (tri-cl)	>360		45		60	30		1	25
Polychlorinated bp's		>480	>180	60	>480		150V		>480
Sodium hydroxide	>360	>480	>180	360	360	>360	360	>360	>480
Sodium hypochlorite	>360			360	360	360	360	360	
Styrene	10	30V	60	10	12	30V	30	30	>180
Sulphur dioxide	>360								
Sulphuric acid	>360	>480	>180	80	125	220	360	105	>480
Toluene	10	20V	60	5V	10V	20	20V	10V	>180
Toluene diisocyanate		>480	>120	7			240	480	>480
Trifluralin									
Vinyl acetate									
Vinyl chloride			>180				300		260
Xylenes	10	30V	60V	2V	6V	4V	60	1V	>480
2,4-D									

NOTES * BETEX=BUTYL ON NEOPRENE * RUBBER=NATURAL RUBBER
* NITPVC=NITRILE ON PVC
* V INDICATES HIGHLY VARIABLE DATA

thicker the material, the longer the permeation time. In fact, thickness is so important that even materials that show significant permeation in thin sheets of typically .05 cm as used in light clothing, can have immeasurable permeability in thicknesses of about .5 cm. Thus permeation through very thick synthetic materials such as on SCBA facepieces may not be a serious concern. One must also be cautious of spurious or erroneous numbers. An example of such appears in Table 8 under the data for neoprene. The permeation time of 240 minutes for a material thickness of .02 is hardly correct when so many other data of similar thickness have permeation times of 5 minutes. It is important to verify the data used with more than one source.

A few cautions should be noted in selecting totally-encapsulated suits:

1. There are no standards governing the construction of such equipment, thus extra care must be taken by the buyer to ensure that any purchase decision is correct,
2. One must ensure that any permeation data are that measured for the actual suit material and are generated by a standard method, preferably the ASTM method,
3. Suits that interfere with the face-seal of the SCBA should not even be considered for purchase; such practice is against most occupational health laws and is dangerous,
4. Gas-tight suits often have several materials, so permeation of the weakest material is the limiting factor. Permeation of each material should be measured, as well as the joint between them. Because of the complexity of such data, it may be wise to avoid multiple-material suits,
5. The suits should allow access to the controls of the SCBA, irrespective of whether the SCBA is worn inside or outside the suit. It is for this reason that many responders prefer that the SCBA be worn outside the suit,
6. Caution should be observed in dealing with sales staff for totally-encapsulated suits: many are not aware of the intricacies of spill response, respiratory protection, safety at spill scenes and permeation data and thus may provide incorrect information or information of marginal value, and
7. A survey of other users should be made to ensure that any potential purchase has user experience and has performed in actual practice.

The selection of boots and gloves should be made on the basis of permeation data as well. The selection of other clothing material is less critical. Coveralls and such clothing are not worn when there is a skin-penetrating material spilled. Disposable coveralls are now frequently used at spill scenes and are very useful for minimizing contact with the substance. Treated cellulose fabrics are now more popular than Tyvek because of their greater comfort. Goggles are used occasionally at the spill scene if there is a danger of material getting into eyes. Splash guards are also occasionally used, but their use is not encouraged. They were originally designed for spark and projectile protection for grinders, welders and construction workers. They protect from flying objects when they are directly projected at the guard. In the case of liquids and in the case

TABLE 8 EXAMPLE OF VARIABILITY IN PENETRATION TIMES
(THE CASE OF BENZENE)

MATERIAL	PENETRATION TIME (min.)	MATERIAL THICKNESS (cm.)
BUTYL RUBBER	5	0.01
	5	0.02
	40	0.02
	20	0.02
	30	0.04
	30	0.04
	8	0.04
	60	0.06
	80	0.08
NATURAL RUBBER	1	0.02
	2	0.02
	2	0.03
	2	0.03
	3	0.05
	3	0.05
	7	0.06
NEOPRENE	5	0.02
	240	0.02
	5	0.03
	5	0.03
	7	0.04
	6	0.04
	7	0.04
	7	0.04
	17	0.05
	11	0.05
	16	0.05
	6	0.05
	20	0.06
	15	0.07
	24	0.07
	1	0.08
	25	0.08
	16	0.08
	40	0.08
	24	0.08
	8	0.08
	60	0.16
	190	0.24

of spills, the materials can be at ground level and can actually be directed to the face by the "splash-guard" because of the open area at the bottom of the device. Hard-hats and ear protectors should be used as required in regular situations.

The Protection Program

Response to chemical spills requires a complete program involving the elements of medical testing, training, retraining, and practice. The equipment-related phases of acquisition, maintenance, upgrade and replacement are also a part of the program. Someone in the organization should be designated to supervise, coordinate and develop the program. There exists a body of literature to help with establishing a recognized and systematic program. The program should be based on a carefully-developed policy regarding spill-site entry procedures and minimum training/equipment requirements. Organizations such as Environment Canada and the U.S. Environmental Protection Agency have had programs and policies for many years. For example, these organizations have policies which state that everyone must have a minimum of one week of training in the equipment use before entering a spill scene and that a refresher of at least one-day must be undertaken every year. Environment Canada, for example, has issued their responders with an SCBA and a totally-encapsulated suit with all the accessories. This equipment is signed out by the individual and is his(hers) until he(she) leaves the program. The equipment is repaired and replaced at regular time intervals.

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HEALTH AND SOCIAL SERVICES RESPONSE TO DANGEROUS GOODS EMERGENCIES

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The risk of major accidents resulting from various industrial activities and transportation of dangerous goods should ensure that we make the effort to be able to define their nature and foresee their consequences. This is especially true since we need to provide for the protection of human life and prevention of suffering due to exposure to chemicals.

The expansion of industrialization in a climate of technological competition has produced the concern of major hazards. The number of disasters on industrial and other sites has produced a feeling of insecurity. In such accidents the factory personnel are the first target and are directly affected but the extent of the indirect effect on the surrounding population, nothwithstanding evacuation, should not be forgotten.

As we consider different approaches to dealing with such incidents we realize that for the greatest effectiveness in medical/health intervention requires a multidisciplinary approach. First, the factory personnel should be trained to provide first aid to fellow employees. Occupational health personnel will also be involved in early treatment of exposed personnel. Links should be made to ambulance services and emergency departments in hospitals, in the planning stages, to advise them of the type of patient they may be dealing with and the type of chemicals to which they may be exposed. For example, would the patients be exposed to substances causing burns, inhalation problems or can the substance be absorbed through the skin? This type of information will allow the emergency medical personnel in hospital to plan for decontamination of patients, to have on hand any special antidotes and to determine if any special treatment protocols are required.

Knowledge of treatment protocols is critical in the mass casualty incident handling when time is of the essence; this only serves to emphasize the need to share information in advance. Additionally, the resources and logistics required to handle a mass casualty situation could be complicated by the types of injuries sustained by the casualties; for example, a large number of persons with serious burns could overburden not only local facilities but put pressure on more distant facilities as well. In 1978 in Spain a road tanker carrying propylene crashed and exploded near a campsite - the resulting fire caused more than 150 fatalities and produced a large number of burn victims to be hospitalized not only in Spain but in several other European countries.

In responding to a major accident we will require not only hospital and ambulance personnel but also biologists, chemists, environmental health personnel, toxicologists and epidemiologists to name but a few of the potential players.

In some situations the affected community may not be able to deal with the effects of the disaster. In this case assistance may be required from the services of other communities nearby and this too should be the subject of pre-planning. Two types of problems are possible, local health facilities may be overwhelmed by persons exposed and in need of care, or, the facility itself may become a victim of the disaster.

Critical also is the evaluation of the situation and the classification of the accident. Even in the early stages following the incident protective measures are a high priority. Monitoring and evaluating the human and environmental health impact of the incident as well as the consequences of changes over time on the affected population and area, are essential to the effective handling of the situation.

Chemical accidents may also affect the health of the population causing changes in the morbidity and mortality. The health effects should be classified in terms of their nature, duration, reversibility and extent. Illness caused by chemical accidents may be immediate or delayed. Because delayed illnesses are more difficult to associate with the incident consideration should be given to epidemiological studies and clinical surveys over an extended period of time. Morbidity and mortality should be quantified and classified by age, sex, type of exposure (accidental/occupational), type of illness and/or primary cause of death.

Thus far we have considered primarily the health problems associated with chemical incidents. Many chemical accidents have resulted in the evacuation of large numbers of people and this leads to the need for a variety of services. Reception Centres should be set up to identify the needs of the evacuees. Evacuees should be registered and, depending on the time of day, family members may be separated therefore inquiry services may be needed so that families can be reunited as quickly as possible. Both evacuees, who will not have the facilities to prepare their own food, and disaster workers, will require the establishment of an emergency feeding program. Depending on the length of time people will be away from their homes, emergency lodging may be necessary. Families need privacy and therefore should not be held for long periods in congregate facilities.

Information services are also an important need and efforts should be made to keep the affected population up-to-date with developments, respond to their need for information on the implications of the situation and the need for specific information on personal concerns, i.e. should a mother continue to nurse her infant. Outreach programs should also be established to help the affected population deal with the psychological stress and uncertainty associated with this type of incident.

In any large scale incident one must also keep in mind the need to deal with the news media who will want regular information on the incident, what is being done to deal with the situation, protective measures and any other information relevant to the situation. Additionally, if there are large numbers of casualties the hospitals should provide for a regular briefing keeping in mind press deadlines and providing an up-date on the care of the casualties. The press area should be away from the information centre for relatives awaiting information on injured family members so that privacy and confidentiality can be protected and, when necessary, counselling can be provided.

A few tips for dealing with the media include appointing one spokesperson at your location and one at the site; keep a log for later reference; establish regular contact and co-ordination of information between the onsite and offsite spokespersons; appoint someone to collect information; never release a written statement without letting reporters ask questions; and, number and post press releases so reporters can update or review their information. Keep in mind that television and print reporters need visual aids and, where possible, accommodate them.

Finally, following the incident, we must consider rehabilitation. For rehabilitation of environmental components full recovery, partial recovery, and alterations are possible, whereas, rehabilitation of human beings implies the return, to the fullest extent possible, to the pre-accident health state through post-emergency health care. In order to deal appropriately with the incident and enhance the rehabilitation of affected persons we must have access to relevant information; assistance of highly qualified experts; services of qualified, reliable, and well equipped laboratories to perform the necessary analyses and tests; provision of skilled personnel to deal effectively with the emergency; and, provision of material and equipment to provide adequate protection and remedial measures.

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EMERGENCY HEALTH SERVICES AND THE DANGEROUS GOODS EMERGENCY RESPONSE

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Each province in Canada has an Emergency Health Services and, each province has its particular place in the governmental hierarchy for Emergency Health Services. Originally, the primary responsibility of Emergency Health Services was wartime planning. As part of the planning the Government of Canada developed and financed the production of several Emergency Casualty Care Units. These units were proportionally allocated to the provinces to be prepositioned throughout each province with the understanding that they would remain the property of the Federal Government. The provincial Emergency Health Services undertook the task of storing and maintaining the security of these units, which were to be located in strategically placed depots in accordance with their wartime Casualty Care Plan. This necessitated the development of plans that would make certain enough personnel could be assigned to each unit and,that the units could be transported to their operational sites as efficiently and as expeditiously as possible if it were necessary to activate them.

As we are all aware, war has not intruded on Canadian soil. It became obvious then that, rather than allow some of these wartime Emergency Casualty Care Units to lie unused and be allowed to deteriorate, perhaps they could be used in peacetime emergencies. Twenty years ago one province began making preparations to use one such unit for just that purpose. This unit is called a Casualty Collecting Unit. Its chief components are stretchers, blankets and first aid haversacks. Originally, this province received twenty Casualty Collecting Units. By dividing each unit into one third sections Emergency Health Services was able to provide sixty municipalities with a minimum of twenty stretchers, forty blankets and twelve first aid haversacks. This amount has grown over the years. Now, one hundred fifty eight communities have been provided with these supplies. In the 1960s such a largess was a godsend to most communities whose ambulance services varied from very good to poor to none. Even today, although ambulance services have been much improved in many communities, these items provide a valuable adjunct to the Multiple Casualty Reception section of the Municipal Emergency Response Plan. It would be appropriate if the location of these items and the community official responsible for their safekeeping were incorporated in the Dangerous Goods Emergency Response, if this has not already been done.

There is an axiom which succinctly states, "A moron writes the plan so an idiot can understand it." This is true. Nothing should be taken for granted in the writing of a plan. It should be as uncomplicated as possible. With the increase in the fluidity of movement of the labor and professional forces today, regardless how many exercises are carried out to test a plan, there is always the possibility that some key people may become involved, who are not altogether familiar with the Plan, if it has to be activated.

Many people who have been charged with the responsibility to develop a plan become so involved with the "what if" syndrome that their final plan becomes so complicated that by the time it can be properly activated the emergency has become a disaster, along with the response to the emergency unless a person institutes some "on the spot" common sense procedures to deal with the situation. The KISS principle, then, still holds true today in plan writing, "Keep it simple, sir."

In the course of developing the Multiple Casualty Reception Plan for Acute

Care Centres it is advisable to prepare a model plan. This Plan can be designed to be expanded or enlarged to meet the needs of large metropolitan Acute Care Centres or be compressed to conform with the needs of rural Acute Care Centres based on their emergency health care capabilities.

The Plan, itself, would be no more than six pages in length. The primary page in the Plan is that which outlines the response to an incoming emergency call concerning a major accident, which might result in a large number of injured who would have to be transported to the Acute Care Centre for treatment. The response is to be designed so that portions or all of the Plan can be activated depending on the information provided from the accident site. In other words, based on the information received by the Acute Care Centre, a decision can be made by the person in charge whether to activate the Plan or, if the Plan is activated, how much of it will be used and, as conditions change expand it if needed.

All instructions on this response page are best put in concise point form. For example, "Alert the Fire Service. Alert the Police Service. Alert the Ambulance Service." This may result in duplicate calls being made to some of these essential services. However, it does make certain that they have been alerted and, no one can presume that some one else had carried out this primary function.

The six page Plan will require some augmentation. To accomplish this augmentation, check sheets are prepared. Each check sheet will be in concise form. The instructions are best conveyed in point form. It is advisable to have the first check sheet titled Administration. It provides the person in charge with precise instructions on putting the Plan in motion. Explicit instructions are needed to ensure that all the communication requirements are carried out by a Communications Officer according to the directions provided in the Communications check sheet. The same is true for the Evacuation Officer, who is responsible for the evacuation of patients from their beds to provide space for the anticipated incoming injured. In most instances, it has been found that more than eighty percent of Acute Care Centre patients can be moved to an internal Holding Area. Then, if necessary, and when conditions permit, these patients can be transferred to their homes or, to another Acute Care Centre which is not involved in the Multiple Casualty Reception incident.

There is a requirement for a check sheet for each Acute Care Centre unit. One of these would be the Triage Area where each incoming casualty is examined by a Triage Team. Here, a decision is made to which treatment centre within the Acute Care Centre the injured person will be sent. These areas would be Resuscitation, Burns, Emotional Trauma, Neurological Injuries, Fractures and Minor Injuries etc.

Prior to the casualty being received in the Triage Area, a Triage Officer would meet each ambulance and conduct a cursory examination of the injured to determine the priority of reception for each casualty. This is a procedure to attempt to ensure that the injured are received by the Acute Care Centre in a descending order of care requirement. This care priority begins with life endangering injuries, such as airway problems, burns, harmhorraging, emotional trauma, injuries to the Central Nervous System, injuries to the Digestive System and so on. In addition, each support unit, such as Supplies, X-Ray, Medical Records, Pharmacy, Respiratory Therapy, Pastoral Care etc would have its check sheet. A minimum of thirty check sheets are required regardless of the size of the Acute Care Centre. All check sheets should include directions for supply requirements, staffing and emergency treatment procedures where applicable.

It has been found that most people will not read a Plan from beginning to the end unless, they are Planning Officers or, are professionals in Emergency Preparedness. Staff members of Acute Care Centres do not fall in those categories. They do not read plans. However, by using a concise Plan supplemented with Check Sheets the Staff members of Acute Care Centres need to know only the six page Plan and the Check Sheet designed for the area in which they would be expected to provide their services. As a matter of fact, the check sheets can be so designed that a new staff member could act responsibly, if the Plan had to activated, by following the instructions outlined in the check sheet provided for the area in which they would be working. In small rural hospitals the check sheets could be distributed to the various staff members on duty and, to the staff members who are called in through a telephone callout procedure initiated by the Communications Officer. This procedure would be carried out from the area designated in the Administration check sheet as the Acute Care Centre control Centre. In larger hospitals, the check sheets would be permanently located at the specific unit, easily accessible for quick response.

The Model Plan is designed in the manner described to provide continuity and uniformity in plan format for the Acute Care Centres in a province. This procedure ensures that staff members can move from one Acute Care Centre to another and readily comprehend the Multiple Casualty Reception Plan of that Centre. They would not have to learn a new "Play Book". Another feature of this type of Plan is that it can be designed to complement the Municipal Emergency Response Plan. It becomes a part of the complete Community Plan.

Inclusion of the Multiple Casualty Reception Plan into the Community Plan should not create any significant problems in rural communities having only one Acute Care Centre. The important factor for efficient response, in this instance is the coordination of the Plan with the Municipal Emergency Response Plan and, that the Communications Officer completes every instruction outlined in the Communications Check Sheet. This would include, for example, notifying other Acute Care Centres in the area. In addition, it would be advisable to notify at least one major Acute Care Centre in the large metropolitan area where the more severely injured might be transferred for more intensive care. Alerting ambulance services, of course, is included in this procedure.

In communities that have two Acute Care Centres it would be advisable to coordinate the Plans in such a manner that neither Acute Care Centre would be overwhelmed and, that sufficient staff would be called back to meet the needs of each Centre.

In Major metropolitan areas where there is a multiplicity of Acute Care Centres it is imperative that the planning procedures make sure that there is an equitable distribution of casualties among the Centres. To this end, a Health Advisory Committee, with membership representing all the Care Centres in the area, can greatly assist the Municipal Emergency Planning Committee in designing an efficient Municipal Emergency Response Plan. In addition, the Health advisory Committee can provide the assurance of cooperation, coordination and continuity in Emergency Health Planning. An example of one of its planning functions could be the determination of one Acute Care Centre to become the "Health Control Centre" in a Multiple Casualty Reception Plan if the accident was of such a magnitude that several Acute Care Centres would be involved in receiving the injured people. With proper inter hospital/ambulance communications the injured would be properly transported, especially in the initial stages, to the Acute Care Centre most capable of providing the specialized treatment that is required for certain injuries. Severely burned people, for example, would taken to the Acute Care Centre with specialized burn treatment area; the casualties with neurological injuries would go to the Acute Care Centre specializing in that type of injury. Upper respiratory injury victims might be sent to several Acute Care Centres to avoid creating congestion in one Acute Care Centre. This would be the same for ocular injuries. In addition, not only treatment space needs to be taken into consideration, but also, the number of specialists available to treat certain types of injuries. These specialists, for example, would be urologists, neurologists, ophthalmologists and specialists in maxillo - facial injury treatment. Further, requests for additional supplies, staff, instruments, and such would be forwarded to this "Control Centre" for resolution. It should be made clear that, depending on the circumstances and whenever possible, the Acute Care Centre, which is designated as the "Control Centre", should not be intimately involved in the Casualty Reception.

The philosophy behind the decision to design a Model Plan is to provide a planning format which is common to all Acute Care Centres. It helps to simplify the problem of developing the Multiple Casualty Reception Plan. Administrators and Directors of Nursing in Acute Care Centres can not be expected to have the expertise to design such a Plan. It is very difficult to attempt to decipher and understand exactly what another person really wants in developing any type of programme. However, by meeting with the Emergency Planning Committee of an Acute Care Centre and explaining the purpose and the philosophy of each page of the Model Plan, the Emergency Health Services staff can make it a relatively simple matter for the Committee to adapt the Plan to their Care Centre's needs.

In any incident where people are injured, the Acute Care Centre becomes the Casualty Reception Centre. It would be advisable, then, that the Dangerous Goods Emergency Response Plan take this into consideration. It should ensure that the Alerting System being used includes alerting the appropriate Acute Care Centre. Early alerting gives the Care Centre time to prepare to receive any casualties that might result from such an incident. It would be desirable that, when the Care Centre is alerted, it be made aware of the type of accident that has occurred and, be given a quick, rough estimate of the numbers and kinds of injuries that might be expected to be received. With this kind of information a decision can be made whether to activate the Multiple Casualty Reception Plan and, to what extent the Plan should be activated.

One of the major problems which is encountered in the majority of emergency situations is crowd control at the site. The situation arises, also, at the Acute Care Centre that is receiving the victims of the incident. In cooperation with the Municipal Planning Officers, a check sheet for Security can be developed to be included in the Multiple Casualty Reception Plan. In a major accident concerned relatives have been known to beseige the Acute Care Centre. There is, also, the problem of a large influx of news media personnel who will use any method they can devise to gain entrance into the Care Centre. In Alberta, some years ago, when there was a sour gas escape, at the briefing after the incident, the Mayor of Camrose said that the news media personnel appeared to sprout out of the ground like mushrooms after a rainfall. In another instances, where a large number of high school students were severely injured or killed when a train struck a school bus many years ago, frantic parents actually stormed the Acute Care Centre, which was located in a rural community, making the treatment procedures exceedingly difficult to carry out. This problem arose because, at the time, planners had not considered a need for strict security measures. Today, when designing a Multiple Casualty Reception Plan, securing the Acute Care Centre must be placed high on the list of priorities if the Plan is activated. Doors are locked. Guards attend the doors. In rural communities it may be necessary to make certain that the Municipal

Emergency Response Plan includes a list of volunteers who can be called upon to carry out this particular duty.

It is one thing to secure the Acute Care Centre. It is another to prevent people from entering the building without unduly aggravating them. There are ways in which this can be accomplished. It is advisable to locate a Relative Information Centre near the Acute Care Centre. Included in the Multiple Casualty Reception Plan would be a check sheet delineating the responsibilities of the people designated to run the Information Centre. The anxious relatives must be persuaded to go to this Centre to obtain the information they seek. To get the Information to the Information Centre, the Multiple Casualty Reception Plan should include, in the addendums to the Plan, Relative Information Slips. The information needed to complete the slips is obtained at the Treatment Areas, not in the Triage Area. Taking time to get this information in the Triage Area can bring the casualty reception to a slow walk or to a grinding halt, This can endanger the lives of those waiting reception into the Acute Care Centre. As previously stated, onsite personnel providing the Acute Care Centre with information pertaining to the type of accident, the kinds and numbers of injuries to be expected to be received can enable the Care Centre staff to be able to quickly prepare the treatment areas for casualty reception. Also, this information is invaluable to the Triage Teams since they have been forewarned regarding the injuries they might expect to see. This will speed up the triage procedures and make it easier for the Triage Teams to assess the injured to determine to which Treatment Area they are to be sent. In addition, it allows the Triage Teams to be prepared to initiate resuscitative measures, if they are required, without unduly delaying the casualty flow into the Care Centre.

In rural communities, the Relative Information Slip can be taken from the Care Centre to the Relative Information Centre by messengers. In large metropolitan areas, electronic device transmission will speed the delivery of the data to the Information Centre. All information sent in this manner must be written on an Information Sheet and be double checked. It is quite easy to misunderstand someone who telephoning information about an injured person. A simple example could be that bed could be interpreted as dead. This could create great emotional trauma for the person seeking information about a relative. The Multiple Casualty Reception Plan should include procedures to ensure that the public can be made aware that the Relative Information Centre is functioning and what telephone numbers to use to get the information. This procedure should help to alleviate the strain which would be imposed on the Acute Care Centre Communications System.

Ambulance services will be used as much as possible to transport the injured from the accident site to the Acute Care Centre. However, in some instances, there could be a paucity of ambulances and ambulance personnel or, the accident site might not be readily accessible to vehicular traffic. In such circumstances, it would be advisable that the Municipal Emergency Response Plan include the use of the stretchers, blankets and first aid haversacks in its supplies procedures. They could come in handy. In addition, a requirement for the services of experienced First Aiders might arise as a complement to the professionals. They could assist as stretcher bearers to transport the accident victims to an onsite Reception Area after properly trained and equipped personnel have brought the injured out of the danger area. Some could assist professional personnel carry out triage procedures at the Reception Area to ensure, as much as possible, that the seriously injured are sent to the Acute Care Centre, by ambulance, in a descending order of treatment priorities. Some could help to stabilize those who require such treatment before being moved to the Care Centre.

A circumstance which can create innumerable problems is the need to evacuate one or more Acute Care Centres because of a dangerous goods accident. This situation arose in the province of Ontario several years ago when a train with cars filled with dangerous goods derailed. This incident necessitated the evacuation of several Acute Care Centres along with many citizens' homes. This procedure was managed quite successfully considering the logistics involved and, the fact that more than one withdrawal was required. Evacuees were moved to one area and then, had to be moved further away from the accident site.

There is a situation in the City of Edmonton that is a cause for concern for emergency response planners. There is an Acute Care Centre, an Extended Care Facility, a Nursing Home and, a Seniors Lodge adjacent to a much travelled highway on which dangerous goods could be transported. These facilities are located on the east side of the highway; the prevailing winds primarily blow from the west. The area around is quite heavily populated. If a life threatening Dangerous Goods Accident were to occur in this vicinity it would more than tax all the evacuation and transportation elements and, the ingenuity of the officials responding to the accident.

Evacuation procedures must be part of Emergency Planning for Acute Care Centres. It may be found that, at the time the Emergency Evacuation Plan is being developed, most of the Acute Care Centres anticipate using their Fire Evacuation Plan for their Evacuation Plan. However, in most instances, the Fire Evacuation Plan does not go beyond the front door of the Care Centre. This can be rectified by establishing a Reception Centre in safe place for the evacuated patients. In large metropolitan areas, by coordinating Acute Care Centre Multiple Casualty Reception Plans and the Municipal Emergency Response Plan, provision can be made for the equitable distribution of the patients being evacuated. Acute Care patients would be taken to other Acute Care Centres, Nursing Home residents would go to other Nursing Homes and Extended Care Centre patients would be taken to other Extended Care Centres. This can be a stressful undertaking if time is limited. Professional and community resources can be over taxed. It is advisable, then, to include in the Emergency Plan a resource of volunteer workers and transportation resources such as vehicles with communication systems, taxis, buses, vans etc which can be assembled quickly.

It is highly advantageous to use Message Memos, especially in Acute Care Centres. Although a problem is resolved by telephone or by other electronic transmission devices, it would be advisable to record the problem along with its resolution on a form designed for that purpose. The time the problem was received and resolved, along with the persons involved should be recorded on this form also. The primary advantage of this system is, following the closing down of the incident, a Record of Events can be prepared from the data gleaned from the Message Memos. This information will help in assessing the Plan. It can assist in determining what areas of the Plan require improvement and clarification. In addition, if a problem has not been satisfactorily resolved the Message Memo may give a clue why it was not. So many things are happening under unusual circumstances that it is practically impossible to recall everything that has happened and, in what order they occurred when trying to review the response to the incident. Message Memos can help clarify the problem of recall.

As previously stated, The Government of Canada had provided some Casualty Care Units to the provincial Emergency Health Services. Besides the Casualty Collecting Units, there are the Advanced Treatment Centres. The Advanced Treatment Centre is an intermediate casualty care unit. It appears to have limited use in a peacetime emergency. Another Unit is the two hundred bed Emergency Hospital. It has been suggested that it should be released for use in the event a major accident occurs. However, certain factors make its use in such incidents impractical. Except for the Training Unit, with which each province is supplied, all other Units are strategically stored throughout the provinces and are prepared for long term storage. By the time the Emergency Hospital was removed from storage, transported to the accident site and assembled, in all probability most of the injured would have been moved to an Acute Care Centre. In addition, the Emergency Hospital is the property of the Federal Government and, permission must be obtained to remove it from storage. The Government of Canada has sent theses Units to various countries where volcanoes or earthquakes have destroyed the majority of Acute Care Centres in the area. In such instances there is a place for the Emergency Hospital. However, in a peacetime accident, the best way to use it would be to provide beds and blankets from the Training Unit to a Reception Centre where evacuees have been located and are expected to remain there for some time. This procedure, then, becomes more of a support measure to the Emergency Social Services.

It has been found that few Municipal Response Plans have included the local health units in their callout systems. If this has not already been done, it would be advisable that the planners consider including the Health Units in the Dangerous Goods Response Plan early callout. Many Health Units have their own Emergency Response Plan. The staff are prepared to carry out their emergency responsibilities and, to act as consultants to Municipal Officials in matters pertaining to Public Health. Their services are required where such health problems arise, such as food and water contamination, sewage removal, human and animal body removal etc.

The role of Emergency Health Services, among other responsibilities is to make sure that Acute Care Centres have a Multiple Casualty Reception Plan which can be quickly activated with emphasis on Communications, Information, Treatment, Security and, in some instances, Transportation. The Plan should be concise, comprehensive, flexible and, designed to complement the Municipal Emergency Response Plans whether the casualties which might be expected to be received in the Acute Care Centre are the result of natural, vehicular or, dangerous goods accidents.

This has been a rather detailed description of a Multiple Casualty REception Plan with information about certain Emergency Casualty Care Units. The purpose was to give people who are not familiar with Emergency Health Services in Canada a more comprehensive picture how Acute Care Centres could respond if a Dangerous Goods Emergency should arise resulting in a large number of injured people and, how the Multiple Casualty Reception Plan could support the Dangerous Goods Emergency Response Plan.

THE ROLE OF FUNERAL SERVICES IN EMERGENCY RESPONSE

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The effects of a disaster may present serious repercussions to a community and to its inhabitants for many years. Even after the "Emergency" has been contained, there remains much to be done, psychological and emotional aspects of dealing with the aftermath cannot be ignored. Effective planning requires us to consider the fact that in the event of a disaster some may not survive. We are challenged to utilize the resources at hand and work with the professionals in our community to develop a comprehensive and meaningful response to disaster.

The primary role of any individual, organization or department which responds to a disaster call is the care of the injured and survivors. The disaster plan developed by organizations and communities understands this basic premise. To this end, firefighters, medical teams, police, ambulances, hospitals, city officials, utilities, service clubs and religious representatives are all accepted members of the team and valuable resources to be called upon in the time of an emergency. In our enthusiasm and optimism to contain the situation and look after the injured we often overlook reality. In a disaster there will be individuals who do not survive. This paper addresses the issues surrounding the role of Funeral Services during and Emergency Response and the provision of care to mortality cases and their families.

This paper was originally prompted by a dialogue held with a nurse during a "Mock" disaster. The mock disaster exercise involved a public transportation bus colliding with a tractor trailer carrying toxic chemicals which then collided with a school bus. As reported in the newspaper "Thirty people will die and 60 will be seriously injured, with 80 more in shock."(1) The conversation with the nurse was interesting, on discovering my profession (Funeral Director) she asked in surprise and shock "What are you doing here?" Unfortunately, it was only the first time I responded to the question that day.

Later in the day when the exercise was over I had the opportunity to ask the regional coroner where the temporary morgue was located and what procedures were planned? He stated that he couldn't even find any casualties! Apparently they had been told to get on the bus and were subsequently returned to a local community centre.

Observers and referees at the scene stated that realistically the number of casualties would have been much higher due to the nature of a chemical spill and the toxic cloud which would have developed after the crash. There was no way of forecasting how many really would have died but 30 was the minimum. In our community there is no one hospital, morgue or funeral home which could have coped with this number of casualties. There is no central agency which would have the necessary trained personnel, equipment or supplies to cope. It is essential to plan how the funeral profession would respond to such a need.

Not long ago a Funeral Director in the states was actively seeking to become involved in his community's disaster preparedness. He was spurned by the very agencies he was trying to assist. Authorities declared they were adequately prepared for any event which caused multiple deaths. At the Funeral Directors instigation an inventory was taken of these preparations. It revealed, "that the 300 body bags had been destroyed by dry rot; of 100 cots on the list, only 20 remained, because the other 80 had been used and were no longer there; and the two field hospitals were hopelessly outdated."(2) Mr. Thomas Shepardson of New York, the Funeral Director involved, was later to become the first recipient of an American Red Cross award for his contributions to disaster preparedness and work with the community towards disaster planning.

We hope that only the extremely rare disaster would require the use of such equipment. Our hopes do not reflect reality: "Usually, in an air crash, there is extreme dismemberment or mutilation of the bodies. In an Urbana, Ohio air crash, a commercial plane with twenty-six aboard and a small aircraft with only the pilot aboard, collided. A total of twenty-seven met their death but the morgue contained two hundred and ninety-five bags of human remains."(3)

After the Lockerbie air crash in Scotland, metal sealed caskets were required, it ended up that 32 were shipped from Los Angeles and an additional 100 were sent from Tennessee.(4) This was in addition to the basic supplies received from casket distributors in the UK. Even when we think we are prepared we may still require assistance and supplies from others. These actual situations serve only to demonstrate the need for planning in order to identify where personnel, supplies and equipment are held in your community or where they can be obtained on extremely short notice.

In any multiple death situation the procedures taken in the transfer of the remains (especially when on-site identification is difficult or impossible) have to be coordinated between the coroner's office and the identification teams which are sent to the site. To have inexperienced or untrained personnel at such a time carrying out the transfers, can lead to legal and financial liability and tremendous difficulty in identifying the remains at a later time. Without coordination between authorities, the morgue, and on-site personnel, chaos can ensue.

The logistical problems are endless and need to be analyzed and solved. It begins with the transfer of the remains to the morgue, followed by final identification, the preservation or embalming of the remains, funeral arrangements and documentation to be completed, and transfers often to other parts of the country or the world.

Ongoing through all of these details is the care of the next of kin: the families and friends. There is still much to do, even when the injured have been cared for. This work must be done with as much compassion and care as any other facet of the Emergency Response.

After the tornado in Barrie, Ontario, the Toronto Red Cross reported, "[in] the early hours of the morning following the tornado until the close of our operations, we received approximately 5,000 telephone calls from people in Canada and around the world."(5) The concern of friends and the anguish of relatives, the spontaneous expression of concern, the donations of food, clothing, and money are all natural reactions to a disaster. One first copes with the concrete; the necessities of food and shelter, and then one must cope with the emotional and psychological trauma.

The effects of the disaster linger far after the physiological necessities of food and shelter have been provided. The psychological well being of the individuals involved in the disaster and of the community must be addressed. The Funeral Director's role as caregiver to the bereaved has a long history. There is more to any disaster than rescuing the living and identifying the dead. There is a vast need for greater communication and therapy for the survivors and the bereaved. The Funeral Directors in most communities are eager to assist and add their knowledge, expertise and experience as well as vital equipment and supplies.

Any article reviewed, addresses the psychological and emotional factors which are experienced after a disaster and uses terms such as shock, anxiety, anger, sorrow, disorientation, guilt, sleep disturbances, confusion and finally reorganization and rebuilding. All of these terms describe the grieving process whether the loss is due to a death, the loss of home, livelihood or whatever.

The immediate need at the site and at the morgue is to coordinate the care of the families by professionals and experienced volunteers. The ministry, palliative care nurses, and Funeral Directors are examples of individuals with training in crisis intervention at the time of a death. Individuals who can cope with volatile emotions, stress, and understand the various pressures a family is under. The Funeral Director is a valuable resource which can, and should be utilized to help the community deal with its loss and begin the healing process.

Even after the emergency has been contained, there is much to be done. The aftermath of a disaster affects a community and an individual for many years. The psychological and emotional aspects must be addressed. We cannot turn a blind eye and ignore in our planning, the fact that in a disaster someone will not survive. This paper is not meant to detail the exact procedures a Funeral Director would use in an emergency situation. Instead its objective is to heighten awareness of the valuable role a Funeral Director serves in an Emergency Response. Call upon the resources at hand and work with the professionals in your community.

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WHO CARES FOR THE HIDDEN VICTIMS
- AN INITIATIVE IN TRANSPORT CANADA

Marc-André Boucher

A considerable amount of interest has developed in recent years in the field of traumatic stress, its nature, its occurrences and its effects not only on immediate victims but also on the "hidden victims", those who respond to natural and technological disasters.

Post Traumatic Stress Disorders result from sudden, dangerous and overwhelming events where individuals are exposed to horror situations (the experience of raw death and destruction), or terror situations (the threat to one's self).

TRAUMA

Experiencing a traumatic event often results in the disruption of one's basic belief system upon which a person has ordered his/her experience and his/her sense of reality. (Young & Erickson, 1988). Traumatic events have a tendency to overwhelm the coping skills of an individual and leave him/her in a state of emotional turmoil and vulnerability. Though these are normal reactions by normal people to abnormal situations, they are too often considered by the victims themselves as unusual and abnormal.

Disaster workers are professionals trained to deal with various emergencies and to control the situations which they encounter; however their preparedness to the emotional and perceptual reality of their work is sometimes overlooked, and they become the hidden victims of disasters. They should also learn to deal with fear and vulnerability and accept that these feelings come from the perception of danger and are not a sign of weakness.

Hidden victims have been identified by Taylor and Frazer as those whose occupation and duties require them to respond and deal with the obnoxious aspects of an emergency while dealing with the emotionally disturbing aspects of their tasks.

Not all disaster workers develop Post Traumatic Stress Disorders, but it has been speculated that 80 - 85 per cent will show signs of distress at the scene or within 24 hours; with no intervention, half of these will maintain signs of distress more than 3 weeks after the incident and of this group, half will continue to show signs 6 months to a year following the disaster.

A traumatic experience is defined by three characteristics:

1. a critically high level of stress,
2. the event is reported by the individual as "traumatic" (Oh Shit !! phenomenon),
3. a group of feelings which may include depression, anxiety, anger, numbing and denial, among others.

A traumatic event does not disappear from the victim's memory; she/he must learn to accept that their outlook on life will be changed and adapt to this new reality. In order to rebuild their identity and to regain a sense of continuity and mastery over their lives, they must be able to form images of themselves which include the traumatic event. (Young & Erickson, 1988).

To do this positively the individual must work through their experience; persistent reexperiencing of the event (flashbacks, distressing dreams and/or feelings as if the traumatic event was recurring) will combine with periods of avoidance and denial (avoidance of the actual disaster site, numbing of responsiveness and so on). This natural process forces the restructuring of the person's belief system and will contribute to the growth of the individual.

PHASES OF DISASTER WORK

The American National Institute of Mental Health describes disaster work in four phases. (For the purpose of this discussion the Alarm Phase and the Mobilization Phase will be combined).

1. The Alarm/Mobilization Phase

The workers individually and collectively attempt to comprehend and adjust to the news of the disaster. She/he may attempt to make sense of whatever facts and information are available.

The worker may feel stunned, demonstrate signs of disbelief, have anxieties as to what will be found at the scene, how she/he will perform.

Following the Alarm Phase, the emergency personnel recovering from the initial shock will then respond according to the emergency procedures and training.

2. Action Phase

This phase may last a few hours, a few days or even a few weeks. Workers actively and constructively work at the necessary tasks. A high level of activity and a high level of stress occurs. During this phase feelings of dread and helplessness may change, the worker may perceive himself/herself as slowing down, of not really being there (out of body experience), being very lucid and alert to everything happening around them; workers quite often in the face of adversity will function diligently and often heroically, ignoring their own fatigue and injuries.

Workers can feel "high", invulnerable, develop strong identification with the victims, experience disorientation, slowness of thought, poor or impaired judgment, tunnel vision and loss of objectivity.

3. The Letdown Phase

This phase involves the return from the disaster operation to the normal routine of work and family life. It is often the most emotional period for workers. The feelings that were repressed, denied or put on hold during the action phase now surface.

In addition, workers may experience feelings of sadness and loss as they move out of the disaster mode of functioning, they may question their performance during the emergency, they may feel a need to contact the survivors of the disaster and so on.

SIGN OF TRAUMA

A number of signs are related to trauma and the person's attempts to deal with the events. The reexperiencing of the episode is certainly the most obvious, but other signs can be identified under the headings of profound psychic numbing, alienation, isolation and withdrawal and finally problems with intimacy and interpersonal relationships.

a) profound psychic numbing occurs when the worker's sense of self is disrupted and she/he may experience a loss of identity. A traumatic event is difficult to integrate because it does not clearly fit most workers' views and assumptions about the world; though training and simulations will help him/her in this task, it is impossible to duplicate the harsh realities of massive destruction, terrible sights or impending danger.

The worker may lose interest in activities and develop a restricted range of emotions. A trauma victim tends to become "stuck" on the episode, show signs of increased emotionality (tearfulness, general malaise, longing and pining). He/she may feel the need to talk continually about the event while quite often alienating others.

b) alienation occurs when the worker feels outside the mainstream of society and sometimes feels unworthy of participating in society. The person, when restructuring his/her beliefs, may find that the emerging values and standards may compete with the established ones, creating an internal conflict that she/he does not understand or believes others will not understand.

It is also difficult for these individuals to clearly express their confusion and they may feel different from others. Their confusion may result from their inability to "put it together", of not fitting in, of having failed the test, of feeling guilty for what they have done and for especially what they have not done (the "What if?" dilemma), of not knowing who they are and what they want.

This alienation results in the person isolating himself/herself and withdrawing to search for a sense of personal control through a self-contained life-style. This can be accomplished by the establishment of a "brotherhood" where other hidden victims share their experiences and membership is restricted (quite often at the expense of spouses and loved ones).

c) isolation and withdrawal results when the worker, recognizing the uniqueness of his trauma experience (even though a number of people and agencies are involved in disaster work), separates his/her life experiences from those of others. The unilateral conclusion that no one understands can translate itself into a lack of trust in co-workers (especially if someone has "failed") or in the system. The individual may wish to separate himself/herself from any memory attached to the event or the possibility of any reoccurrence.

This constriction of activity will impact on ambitions, sex, vocational strivings and interpersonal relations.

d) problems with intimacy and interpersonal relationships occur when the person, restructuring his/her beliefs and inner world, finds it difficult not to be preoccupied by "self". There is a reluctance to be happy (even a feeling of guilt in being happy) after being a witness to severe hardship and pain, there may be a hesitation to reestablish a sense of humanness and a sense of continuity.

The exposure to the reality of death or the realization that they have exposed themselves or others to eminent danger often reminds employees of their own vulnerability; they may feel an unreasonable concern for the welfare of their loved ones and a need to protect while refusing to get close to them, fearing their eventual loss. (Young & Erickson, 1988).

CRITICAL INCIDENT STRESS DEBRIEFING

Critical Incident Stress Debriefing, a procedure developed by Jeffrey Mitchell, Ph.D. of the University of Maryland is considered an effective intervention technique which allows disaster workers to return to a healthy way of life following their involvement in an emergency situation.

It is defined as an educational and psychological process used to mitigate the impact of a critical incident on individuals.

It consists of two parts: a pre-event education portion to help employees become less vulnerable to the harmful effects of stress and trauma by learning more about stress and by learning ways to cope in traumatic situations; the second part, the post-event debriefing "enables employees to alleviate the acute stress response which appears at the time of a disaster or immediately afterwards and helps to eliminate or inhibit delayed stress reactions".

In his article "When Disaster Strikes", Jeffrey Mitchell describes the three-part debriefing session:

> the first part allows for the initial ventilation of feelings by the disaster work and an assessment by the facilitator of the intensity of the stress response in these workers;
>
> the second part entails a more detailed discussion of the signs of the stress response and provides for support and reassurance from the facilitator that indeed their reactions are healthy and normal;
>
> the third part is the closure stage where information is provided, a plan for further action is discussed and, if necessary, referrals to Mental Health professionals are made.

The debriefing session itself should occur optimally 24 to 48 hours following an incident, but can take place as long as 2 weeks after the incident, though the effectiveness will be diminished, the facade developed by many emergency workers will have had the opportunity to reform.

Disaster workers should be given this opportunity to share confidentially their experiences, thoughts and feelings while learning the various physical, emotional and intellectual signs which may occur in the following days, weeks or months. Through these directed group discussions, participants will understand that their reactions are normal and healthy, rather than allow themselves to feel alienated from their group and loved ones and continue towards increasingly disruptive behaviour.

It is unfortunate that we must learn from the tragedy suffered by others. In Transport Canada this statement also applies; the tragedy of Air Arrow in Gander, Newfoundland in December 1985 awakened us to the reality of air crashes and the impact they have on emergency personnel. It has also brought to the forefront other realities (security alerts, bomb threats, search and rescue operations, hostage takings, suicides, death in the workplace) which also impact and influence the health of employees. The positive and rapid acceptance by senior management for the Critical Incident Stress Debriefing Program is a tangible demonstration of Transport Canada's interest for their employees.

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STRUCTURED COMMUNICATIONS FOR EMERGENCY RESPONSE

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ABSTRACT

Because effective communications is vital in an Emergency Management System, a "global view" or "big picture" of everyday communications systems is necessary in order to achieve the response necessary from an Emergency Communications System.

This global view or "model" is the combination of equipment, procedures and methods integrated to accommodate incidents of different size and scope and single or multi-jurisdictional involvement.

The realization of the model can be achieved through mutual understanding, concern and cooperation between users in government and industry by considering that the historic application of communications (i.e to *"provide for one's own agency"*) is superseded by the larger goal of needing to also provide for multi-agency involvement such as during an incident involving Dangerous Goods.

INTRODUCTION

The need for effective communications during an emergency is a well established principle. Case studies often point to the lack in proper links as being a causal item to delay in response, resulting in increased difficulty in containment, and the greater potential for loss of life, injury, property and environmental damage. Time is of the essence and the mechanism, of "how-to" convey ideas, or more properly, information, in a timely manner to intended recipients, has engaged the individual and collective reasoning power of many people since the dawn of history. The medium of transmitting the message has changed over the centuries. Indeed, in some areas, particularly metropolitan, the vast array of devices from cellular telephone through facsimile and computer communications has led to a plethora such that, in some cases, the original problem of getting the message to the recipient may not have been solved, since the message is "lost" in the sea of information now at hand, and traditional "message handling" techniques also need to be modernized to accommodate the technological *"communications power"*.

The matter of action taken or, alternatively, lack of action taken, as a result of the information received is a subject beyond the intent of this paper.

THE PROBLEMS

Lack of Information:

The key to emergency planning response and containment is **effective communications**. Basically stated, information is needed by someone to make a decision or to be informed of the situation. Usually, that information is "*available*" somewhere within the "*situation*" and is "*known*" either because of one's position (e.g police chief, weather forecaster, etc.) or by someone else to whom the user must "communicate" and from whom information must **flow**. An example is the chemical fire that occurred in Canning Nova Scotia on May 31st, 1986. In this case, the fire department responded, but "*it was not an easy task to identify the various contents of the warehouse (from which dangerous gases were escaping)*"[1]. Initially, the fire-fighters did not know what they had to deal with, the store owner had a "rough idea" of the brands, and while CANUTEC had information on chemical compositions, "*the problem of proprietary names was again evident*".

Over two years later, on January 7th, 1989, the lack of information transfer (i.e communication) was evident in a freight train derailment at Windsor Junction, just outside Halifax. The local highway was blocked, such that parts of the community were cut-off from fire department service. A Railway spokesman was quoted as saying that they "slipped-up" by forgetting to call the local fire department about the problem[2]. Although in this particular incident no dangerous commodities were involved, the information within the *Emergency Management System* did not flow to those who could use such information. A similar incident took place just a few weeks later in the Town of Truro. In this case "*Regulations were followed*". Apparently, in this instance, the regulations did not require the railway to notify the response agencies in the Town but the Municipal agencies *wanted to know about an incident that affected their community.*

The above examples reemphasize that communications or information flow is a matter for more than technology - regulations, inventories and procedures are also necessary. One of the major problems is matching the "source" of information with the "sink" (the user requiring the information), and the technology required is a **responsive communications system** that will enable the **information to flow** given that procedures are enacted for people themselves to properly respond. This responsive system must be viewed *end-to-end*, and not as a collection of individual components that, in some cases, and from time-to-time, may be able to inter-communicate.

Jurisdiction:

In the Canadian context, it is generally recognized amongst the emergency planning community that civil emergencies are initially handled at the municipal level, followed by the provincial and federal level respectively. A particular "emergency" may be within the jurisdiction of a particular municipality and even be the responsibility of a particular group, such as the police department. To the "victim" however, such issues of responsibility, jurisdiction and level of government are of secondary concern.

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[1] Report of Proceedings, Canning, May 31 1986, available through E.M.O (N.S)

[2] Halifax, Mail Star, January 18th, 1989

> *" Emergencies occur on multi-levels, according to one's perspective. For the highway accident victim, or ship-wrecked fisherman, they have an "emergency", and are probably not interested in debating whether it is a "big-one", or a "small-one". If an effective communications system is what is needed to save their life, so be it. At such times, it is, to the victim anyway, a debatable matter as to whether this province or that, this level of government or that, has responsibility or jurisdiction. If their very lives are in jeopardy because of the circumstance that the agency in one province (or level of government) cannot communicate in a timely manner with that in another, it is a cause for concern. "*[3]

Emergency planning:

Emergency planning usually deals with preparing for "an emergency" by establishing plans and procedures that will be "activated". These plans invariably build upon the "regular" roles and responsibilities of the various departments or agencies, although the lead agency such as fire and police may be designated according to the type of incident. In other words, the plan is built upon personnel resources available. In the same way, the communication segment of the plan, if such exists, builds upon the communications facilities available, and may make some adaptations to handle the increase in traffic. However, a basic flaw that could be observed is that while the personnel may not initially be skilled to handle an emergency and hence need procedures and training, similarly, the "everyday" communications facilities that are contemplated for use **may not be adequate either** and "planning" to use that which is "available" without any further recognition of the matter may result in a non-effective system. An example is the common assumtion that a municipal Emergency Operations Centre (E.O.C) will utilise "available" telephone lines without recognising that the emergency will result in these lines being "jammed' by public enquiry unless proper measures are taken[4].

This introduces one of the biggest problems in current emergency planning which conventionally undertakes a number of tasks: a needs analysis, a survey of facilities available, the establishment of, or plan for, a "command network". Such an approach is termed "conventional" because all too often it has been the only practical method. Jurisdictionally, the emergency planner may not have any involvement in the planning of the local municipal police and fire department communications systems. As a planner he takes the facilities available and works with what he has, the problem being that "*what he has*" may-be adequate for the routine (everyday) tasks but when used *even collectively*, inadequate for a disaster.

The deduction therefore is that for effective emergency communications planning we must build from the ground floor (resting on a solid foundation) and ensure that first the "everyday" communications systems are adequate and secondly, that they indeed **can be** readily expanded or re-configured to meet the emergency demand. In other words, we need a system that is **truly** integrated throughout the various agencies and jurisdictions alongside their respective roles in emergency containment.

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[3] E.J.Oldham, P.Eng. in Eastern Canada Working Group on Interprovincial Emergency Communications: Problems and Solutions, January 1986

[4] Examples of these measures are unlisted telephone numbers, out-trunk (versus two-way) configuration for the Administrative building telephone system, public information "desks" and accurate media reports.

Funding:

As an example, a small municipal police department may decide that it requires basic telephone service and a mobile radio system consisting of a base station, mobiles and portables. In a metropolitan area, the police department may determine that its mobile radio system needs extend to Computer Aided Dispatch and/or encryption on the radio units, mobile data terminals and other system features. It follows in this example that the police department may not consider that it has a responsibility to procure a mobile radio system that inter-relates with other agencies such as fire and ambulance. Indeed, funding may be at such a premium, that to suggest ways and means to plan the required police system and allow for "emergency measures" communications may be detrimental to the departments own objective - a communications system for their own mandate within a certain budget. Alternatively, the other agencies may already have an established system and because of spectrum constraints it is not possible to engineer a system operating in the same frequency band as these "other agencies". *Communication systems are usually planned upon the owners perceived need.*

While there are specific national policies in regard to matters such as (a) spectrum utilization and the frequency bands available for different classes of service, (b) the building and use of microwave systems and (c) technical standards for the operation of radio systems, there is no specific policy that guides the development of *everyday* communication systems towards mutually compatible systems for use in emergencies. The fact is that "*he who pays the piper calls the tune*". If a police department in Nova Scotia, New Brunswick or elsewhere wishes to purchase and install a new mobile radio system, they are invariably at liberty to install whatever they see fit within the usual confines of D.O.C radio licensing. There is no structure that says "*this is the best way to go*". Compounding the problem is that adjacent municipalities do not always replace their old systems at the same time and hence the problem for an emergency communications planner becomes compounded.

GLOBAL VIEW

"Big picture"

The "global view" of emergency communications is the "big picture", where vision is not limited by the viewpoint of one particular agency with its particular mandate and responsibilities and its particular technical approach to providing solutions to its own communications needs. This global view will be developed into a "model" which can be used to evaluate the current Communications Plan, or communications system(s).

Concept of information flow

The expression "communications", can be open to interpretation since it may refer to "*what is said, printed, seen etc.*" or the transmission system itself (*telephone, television, etc*). In the context of this paper, it is defined as the transfer of "*information*" between people and/or machines such as computers. We can say that communications is to give and to receive information, whether this is achieved through a conversation in an Emergency Operations Centre, a telephone call between participants, or the transfer of data from a welfare reception area to a central computer. It is the **information** that is needed, the mechanism as to how the information is passed being the communications system.

A paper[5] presented at the World Congress of Sociology, in New Delhi, India in August 1986 describes 10 incidents in Canada and the problems associated with communications. The presentation noted that

> *"it ... is extremely common for emergency response to be hampered by lack of communication among key agencies - (i.e agencies which* ***have information, advice*** *or* ***resources*** *which could be or are being used for appropriate emergency planning and response).*
>
> *..based on the study of more than 40 emergency incidents (mostly Canadian) - suggests such breakdowns occur either (a) when there is no plan or when the key agency is not part of it or considered part of it, (b) when there is no single command post or when the key agencies are not in it if there is one or, (c) when there is no established communications link among the key agency or, if there is one and it fails and the agencies are not aware of the alternatives. "*

An incident begets its own set of problems. Failure of communications can be anticipated, whether the failure is the lack of information flow, erroneous information or a technological failure. The fundamental treatment is effective planning, preparation and training, but in order to plan, a model, or "ideal", is necessary to determine direction.

Emergency Communication systems must be **planned, integrated** and *operated* to the extent that each "piece" of information **flows** to those who can make use of it[6]; the problem being that unless they are made aware through training and exercise, a person with a piece of information may not recognize that it is of value to another and hence fail to communicate. For this reason, the historical manner of establishing Emergency Operations Centres and their communications networks may need to be re-considered or at least **re-emphasised** to the extent that since emergencies and disasters do happen, the communications needed for their containment must be an out-growth from "everyday" facilities rather than "making-do" with what is available or relying upon a plan that requires "borrowing" from other systems (such as taxi dispatch mobile radio) that may well be affected by the same incident. Quite obviously, however, communities can only work with what they have and within budget constraints, and hence the intent of this paper is to present a global model that sets a direction, or goal, that is achievable as the "preferred network" even though it may not be fully implemented immediately, because of political, jurisdictional and economic considerations.

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[5] Inter-agency Communications Failures in Emergency Response: Planning is the answer, Joseph Scanlon and Angela Prawzick, Emergency Communications Research Unit, Carleton University, Ottawa.

[6] An analogy is a road transportation system planned for smooth vehicular flow. Each vehicle is independent and travels to its destination by using the optimum route.

General concept

To create the emergency communications model, some general concepts need to be recognised:

Table I Communications System Design Requirements

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1. The Communications System must support the following kinds of operations:

   a. single jurisdiction/single agency involvement;
   b. single jurisdiction with multi-agency involvement;
   c. multi-jurisdiction/multi-agency involvement.

2. The organizational structure must be able to adapt to any emergency or incident to which the Emergency Management System (organization) would be expected to respond (e.g fires, riots, spills of hazardous materials, evacuations, transportation accidents - aircraft, rail, shipping etc.,).

3. The System must be applicable and acceptable to other groups also involved in the incident - hospitals, fire, police and Emergency Measures authorities.

4. The System should be readily adaptable to new technology.

5. The System must be able to expand in a logical manner from an initial emergency situation into a major incident.

6. System Procedures and Operation must have basic common elements in organization, terminology, and procedures, thus allowing for use of already developed structures within the Organization.

7. Implementation should have the least possible disruption to existing systems.

8. The System must be effective in fulfilling all of the above requirements and yet be simple enough to ensure low operational and maintenance costs.

---

1. Any event can develop into an "emergency":

   At about 9 p.m on July 7, 1987, a truck ran out of control. Loaded with gasoline it crashed into an ice cream parlour killing at least 30 people and injuring 29. The downtown section of Herborn (a town of 21,000 people in West Germany) looked as if it had been fire-bombed and hundreds of firemen took about five hours to bring the flames under control. Initially, a spokesman for rescue teams said up to 50 people were believed missing or dead, although some of those unaccounted for may have failed to register with the authorities.[7]

2. Communications systems are needed in any event to deal with the "everyday" tasks of fire, police, emergency medicine and other response agencies.

3. The system must be able to meet the design requirements[8] identified in Table I.

---

[7] Reported in the Globe & Mail.

[8] Adapted from National Interagency Incident Management System, F.E.M.A handbooks and other sources.

Response cycle

Every incident has a reflex-time, meaning the time that elapses from the moment the incident occurs to the time when the emergency response personnel begin containment operations. An example is shown in Figure 1 for a fire, but other events have a similar cycle.

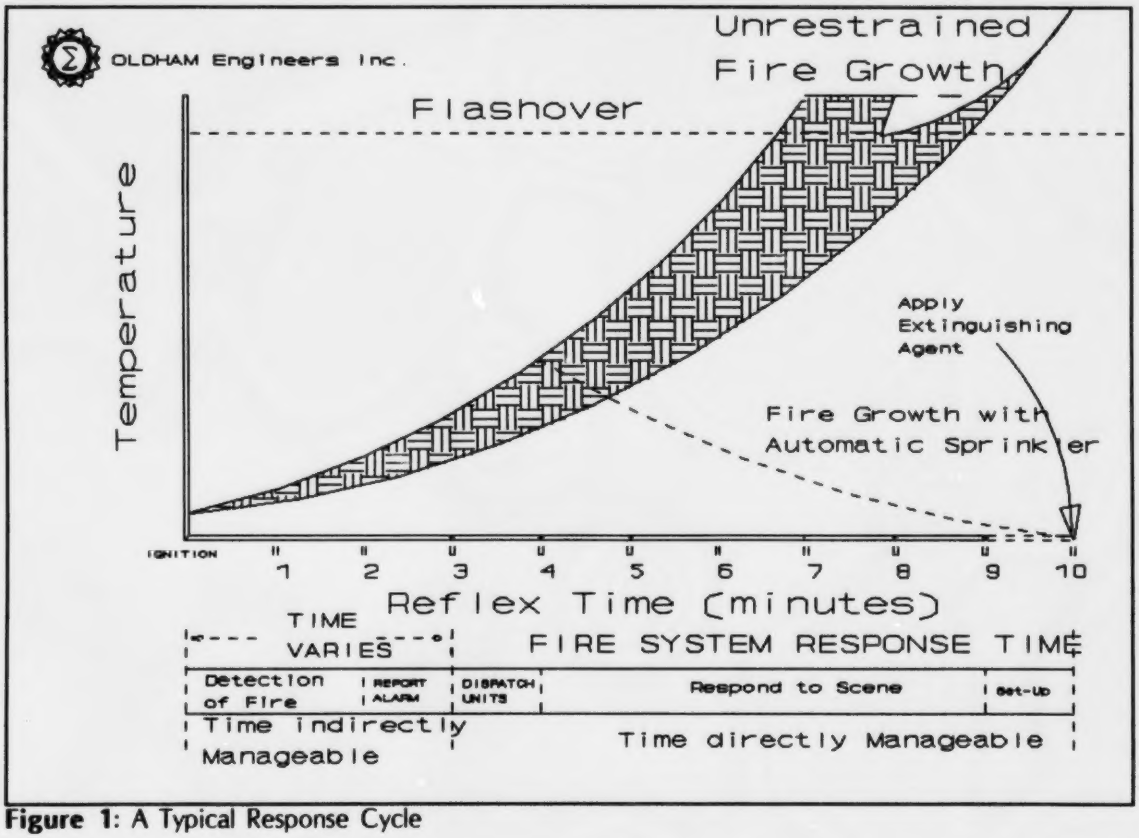


Figure 1: A Typical Response Cycle

Response to an emergency can only occur when the response agency, and in many cases individual members have been notified of the problem and the location. As shown in the example of Figure 1, the *response cycle* follows detection of the fire and call-out of the fire-fighters.

(a) ignition occurs;
(b) the fire is detected;
(c) the brigade is notified;
(d) the fire-fighters are dispatched;
(e) there is a response (including travel) time;
(f) a set-up time; and,
(g) a suppressant is applied, or other appropriate activity undertaken.

All of these events are taken together, is called the "*Reflex Time*", part of which is directly manageable or within the control of a fire department, and part is indirectly manageable. In the fire-service, the fundamental task is the protection of life and property. As indicated in the figure, the quicker the response, the better the opportunity for minimising loss and there are several distinct areas which contribute to the overall response cycle:

Indirectly manageable by the Fire Service Administration

i. The time taken to detect the problem after ignition (or the emergency) has occurred (*c.f the use of smoke detectors*);
ii. The time taken to report the problem (*e.g find the correct telephone number for the fire department, dial, report problem and location*);

Directly manageable by the Fire Service Administration

iii. The time taken to notify (*dispatch*) the fire fighters of the nature and location of the problem;
iv. The location of the fire-fighters with respect to the apparatus (*e.g on-duty fire-fighters in a standby room versus volunteers called-in*);
v. The location of the fire-hall and apparatus with respect to the location of the fire (*affects travel time*);
vi. The time taken to set-up at the scene (*e.g training, use of pre-plan*);

To support the entire operation proper equipment (pumpers, tankers etc.,) is needed as well as appropriate training and other facilities. Since fire-fighters must deal with a variety of situations including hazardous chemicals, the "facilities" need to include not only equipment but also information on matters such as chemicals stored at the incident site, location of stand-pipes etc. In some cases, this information can be compiled in a *pre-plan* for the particular occupancy, a nursing home or hospital for example. This pre-plan forms part of the dispatch function as the information needs to be delivered to the fire-fighters prior to reaching the fire.

Three distinct communications phases are apparent:

Call-in = REPORT
Call-out = RESPOND
Operations = RESCUE

Functional representation of the Model

These three **fundamental** segments are shown in Figure 2 supported by a "feedback-loop". This loop is indicative of the cyclic nature of the incident information flow, since once the operation is under way, reports are "called-in" to provide advice and status information or to request assistance, supplies or other resources.

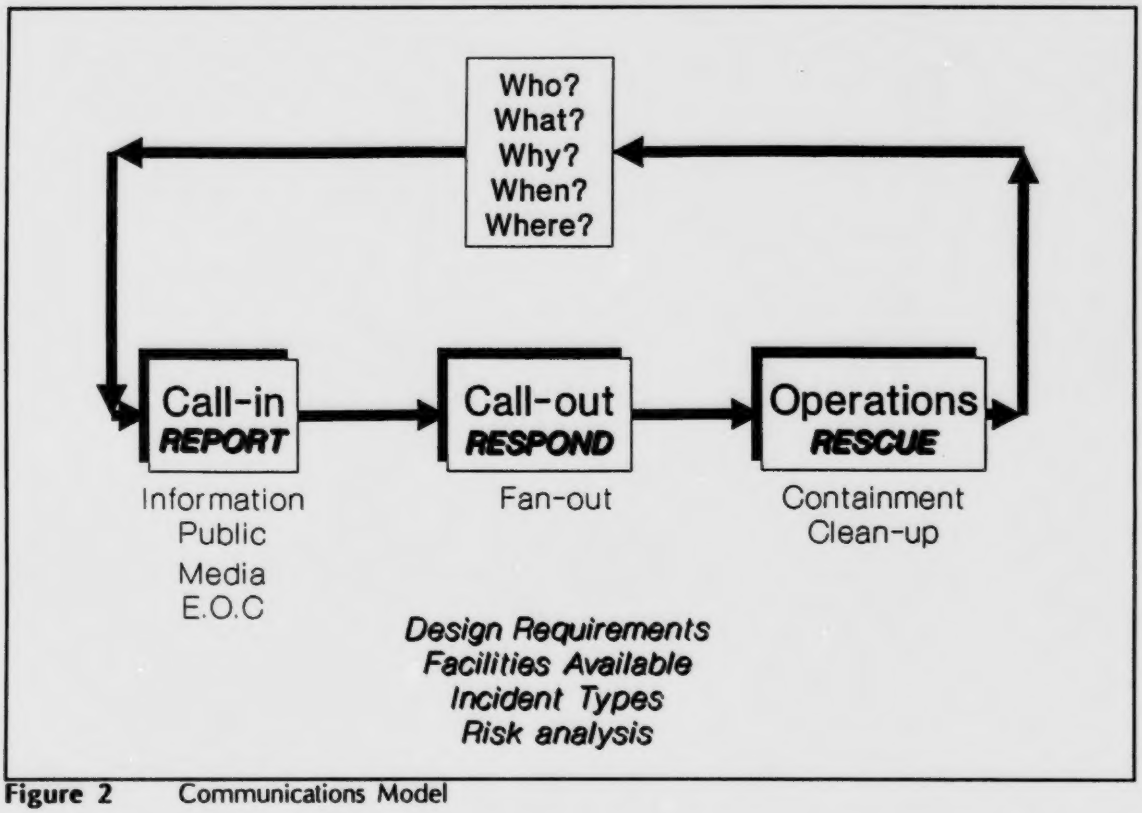

Who?
What?
Why?
When?
Where?
Call-in
REPORT
Call-out
RESPOND
Operations
RESCUE
Information
Public
Media
E.O.C
Fan-out
Containment
Clean-up
Design Requirements
Facilities Available
Incident Types
Risk analysis

Figure 2 Communications Model

This basic "model" provides the foundation for building up (or "layering") the system needed to support the operation. Other sub-elements could be added to depict the complete emergency response cycle. For example the first element of call-in actually consists of the event itself, detection of the event and notification to the authorities; similarly the operational phase would include action taken, closure of the incident and return to standby. Further use of the model can be achieved by introducing to the diagram basic principles such as answers to the questions concerning Communication Needs (the *5 x W's* of Table II), and what facilities are available. Risk analysis will identify the various incident types that might occur? What scale of communications support will be needed? What is available, or what must be built? The Design Requirements of Table I also apply.

In reviewing each of the three segments, the questions are:

1. How does the public "call-in"?
2. How are the responders "called-out"?
3. How is the operational segment supported?

Solutions to each of these questions need to be structured. Most emergency communications planning is based upon the premise that an emergency has occurred, that initial response agencies (e.g police, fire) are responding and that the "emergency plan" is activated. While Emergency

Measures plans usually allow for **call-out** procedures and **operational** communications, all three elements must be considered if the model is to be **global**. The element often missed is the first, referred to as **call-in**, or the reporting of the incident (emergency) to the authorities. It is evident that many communities have a "loose form" of communications such that the total view represented by the model is not realised. To avoid this "looseness", some form or "structure" is necessary in other words, the model represents a **structured communications system**.

Structured communications

One version of a structured system that reflects the call-in phase of the model is a 9-1-1 telephone system combined with response agency dispatch and Emergency Operations Centre attributes that is able to bridge gaps between agencies of different jurisdictions and interests. With state-of-the-art databases and Computer Aided Dispatch, such a "Communications Bureau" supported by the other elements identified in the model can provide an order of magnitude improvement to conventional emergency communications. It provides for an emergency reporting system, a call-out system and a clearing house for information. As an established operation it is "exercised" on a daily basis and fulfils other requirements of the model.

Table II The 5 x W's of Needs Analysis

- Who needs to Communicate?
    - *Key Officials*
    - *Incident Site*
    - *Relief Agencies*
    - *Public & Media*
- What needs to be Communicated?
    - *Tactical Information*
    - *Injured Lists*
    - *General Status*
    - *Is "Granny" o.k?*
- Why it needs to be Communicated?
    - *Emergency Warning*
    - *To help containment/relief*
    - *To answer public concerns*
- When it needs to be Communicated?
    - *Immediately*
    - *Priority*
    - *Routine*
- Where it needs to be Communicated?
    - *Geographic Locations*

APPLICATION OF THE MODEL

Application of the model to the real-life situation is happening, but perhaps in different forms, in many jurisdictions. In Atlantic Canada, Nova Scotia, New Brunswick and Prince Edward Island, all operate "Integrated Mobile Radio Systems". The general concept is that most public service agencies require radio communications and the sharing of infra-structure and other resources is worthwhile and reduces overall costs and results in inter-communication and other efficiencies.

These radio systems can also support the call-out segment such as the use of radio paging by volunteer fire departments. The call-in phase, which is best served by 9-1-1 as an emergency telephone number, is currently being developed in Nova Scotia on a province-wide basis.

Chemical Producers in Nova Scotia, are encouraged to equip themselves with radio units that can access the provincial system and thereby have direct communications with fire departments, Emergency Measures and other agencies.

The intent of the model described in this paper has been adopted by the City of Dartmouth in formulating their Emergency Communications Plan. In this case communications for the Emergency Operation Centre has been established as well as providing for media information and information requests from the public.

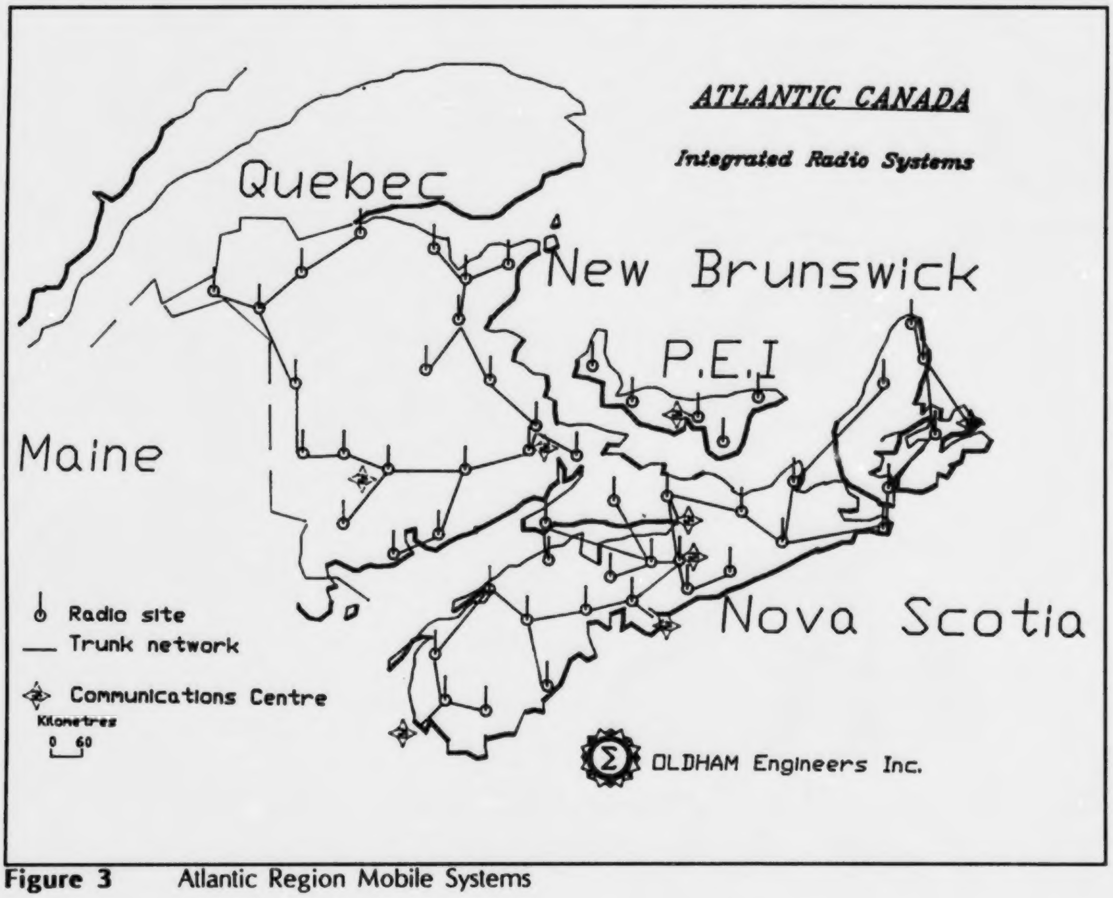

ATLANTIC CANADA
Integrated Radio Systems
Quebec
New Brunswick
P.E.I
Maine
Nova Scotia
Radio site
Trunk network
Communications Centre
Kilometres
0 60
OLDHAM Engineers Inc.

Figure 3 Atlantic Region Mobile Systems

CONCLUSION

A basic premise of this paper is that "emergencies" are a matter of perspective (*compare a single car accident with the runaway gasoline tanker in West Germany, previously referenced*). If, as an *emergency planning* community we are to devise effective Emergency Communication Systems we must adopt the principle of implementing everyday systems capable of the necessary expansion. This concept is no different to that indicated in the summary noted above. What is required is a policy on a national basis that underscores the intent of forward communication planning for emergency services. Naturally, with any policy of this nature there is a price-tag since "*he who pays the piper calls the tune*". In both Nova Scotia and New Brunswick, this policy is practised through the two Integrated Mobile Radio Systems as it affects provincial and municipal agencies.

Emergency Measures plans should begin with an analysis of the potential hazards - risk assessment - and incorporate the results in an all hazards plan. There may also be specific plans to deal with identifiable risks, such as an airport crash plan, or hostage taking plan. These plans should take the "*big picture*" i.e the maximum conceivable hazard, and work downward to hazards of less severity, or hazards requiring command and control structures of a smaller scale than the maximum hazard.

Conventionally, Emergency Communications systems, on the other hand, start at the bottom (e.g the local police radio system) and an attempt is made to work upwards towards a system that will provide the necessary support to the maximum hazard. When operational-radio systems are considered, different agencies may have different operating frequency bands because of the historic "*isolated*" development plus the constraints involved in frequency availability. The ideal would be to organise all public service agencies in the same switching band, but when one has VHF, others UHF, and a third an 800 MHz system, there are quite obvious economic, technical and logistical problems. Common or inter-agency planning is often quite difficult at the local level, increases in difficulty at the provincial level, is certainly compounded at the inter-provincial level and on a national basis takes on gargantuan proportions. Inter-national considerations (such as New Brunswick to Maine) provide an awesome dimension.

While to comment that there is no specific policy and to observe that "*he who pays the piper calls the tune*" is one perspective, it should be countered with a recognition of the difficulty in expounding a policy in a technological environment subject to growth and change. To formulate a policy that *all public service agencies will utilise a specific frequency band* is not practicable given the size of the country, the demand for more spectrum, the vastly different evolution of discrete systems and the trend in some jurisdictions to use the 800 MHz band for example, versus the trend in other areas to optimize the solutions at lower frequency bands. The situation in metro-Toronto is different to the situation in Cape Breton. Nevertheless, there is a need to recognise this reality even if to prevent the syndrome that "*all disasters can be handled effectively with a common channel*".

There are solutions to the problems identified in this paper. The expectation of the public that responders will deal with emergencies, the budget squeeze that is apparent in all levels of government and the private sector, the need to rationalise emergency planning is forcing all players to re-think. If we want effective Emergency Management Systems we must build on what we have available - people & resources i.e the "everyday" system. But the everyday system must be devised with the wisdom and vision to see that it must be capable of being extended into emergencies, not that one tries to pour new wine into old skins.

The Role of Amateur Radio in an Emergency Response

Tom Atkins, VE3CDM, President
The Canadian Radio Relay League, Inc.

Most people know that radio amateurs can and do provide communications in times of emergency. Most people do not know that such communications are rarely an ad hoc effort. When radio amateurs provide emergency communications, they generally do so in the context of a structure sponsored by a national Amateur Radio organization. In Canada, that structure is the Amateur Radio Emergency Service and the national organization is CRRL, the Canadian Radio Relay League.

What is Amateur Radio?

The International Telecommunications Union (ITU) defines Amateur Radio as "...a radiocommunications service for the purpose of self-training, intercommunications and technical investigations conducted by amateurs solely with personal aim and without pecuniary interest". For many radio amateurs, the service is just that. Their interests range from on-the-air activities like contests (contacting a maximum number of stations in a designated time frame), DXing (contacting stations at a distance, especially in exotic places) and ragchewing (just talking with friends), to building equipment and developing new communications technologies. (Some of these are quite exciting: Besides the traditional modes of communication -- Morse code, voice and radioteletype -- many amateurs now use computer-to-computer packet radio; some own and use communications satellites or even bounce signals off the moon.)

All these activities require radio spectrum. Radio spectrum is a finite natural resource divided among its users by the ITU. Radio amateurs are grateful for the spectrum they have been given and they have a tradition of expressing this gratitude in terms of public service -- in North America, through the National Traffic System (NTS, actually a bi-national organization), capable of quickly passing messages on behalf of the general public from any point in Canada and the United States to any other point, and the Amateur Radio Emergency Service (ARES).

What is the Canadian Radio Relay League?

Canada has some 24,000 radio amateurs. All are licensed by the federal Department of Communications (DOC, alternately known as Communications Canada or Com). Radio amateurs are allowed to go on the air only after they have passed a rigorous test in Morse code, electronic and radio theory, Canadian and international regulations, and operating practice. Once on the air, their activities are subject to regulation by the DOC.

The Canadian Radio Relay League, Inc., was incorporated in 1979, under the Canada Corporations Act. It was the outgrowth of the Canadian Division of the American Radio Relay League (ARRL), an organization with a seventy-five year tradition of public service, particularly in the field of emergency communications.

CRRL Headquarters is just north of London, Ontario. CRRL's most important roles are to represent Canadian radio amateurs to DOC, to represent Canadian radio amateurs at meetings of the International Amateur Radio Union (IARU) which in turn represents them to ITU, to provide a number of services to Canadian Amateur Radio, and to provide a framework for public service through the CRRL Field Organization which includes NTS and ARES.

What is ARES?

For purposes of the CRRL Field Organization, Canada is divided into seven geographic areas called Sections. Each Section is headed by a Section Manager who is elected every two years by the CRRL membership. Section Managers appoint up to eight Section-level assistants to help administer various aspects of the CRRL Field Organization. The assistant that coordinates ARES is called the Section Emergency Coordinator (SEC).

The responsibilities of an SEC include promoting the creation of ARES groups at the local level -- which is the level at which most emergencies occur -- and to ensure that these groups follow common guidelines, use common basic practices and meet certain standards set by CRRL.

Most ARES groups are sponsored by local radio clubs. These can be found in most centres in Canada. Each ARES group is headed by an Emergency Coordinator (EC) who must be a CRRL member. CRRL supplies the group with guidelines and various support materials.

How does an ARES group begin its work? First, the group creates an emergency plan. This begins with an inventory of its resources -- human resources, technical and operational know-how, and equipment. The group develops a way to bring members together on short notice. (Usually, this is done with a telephone-calling tree; each member calls, say, three other members who, in turn, call another three. A typical ARES group of 20-25 members can bring its members on the air in 10-15 minutes.) The group determines and maps the coverage of amateur repeater stations (more on these later) in its area. It makes plans to establish Amateur Radio stations in key locations: the local Emergency Measures Organization headquarters, the Red Cross, local hospitals, a police station and the like. It makes plans for providing auxiliary power.

The second step is to present the plan to municipal authorities and have it incorporated into the official emergency plan for the municipality. The municipal plan, of course, outlines the responsibilities of police, fire, ambulance, municipal government, hospitals and various relief agencies in time of emergency. Where doubt exists that the radio amateurs have something to offer, a demonstration does the trick. When municipal authorities are shown how an amateur can communicate from, say, beside a stretcher in the basement of a hospital with, say, the scene of an emergency twenty-five miles away, and when they realize this kind of communications is being offered for free, they become believers. Amateurs have been successful in having their emergency plans incorporated into municipal emergency plans in every part of Canada.

What kind of communications can an ARES group provide?

ARES members generally understand that they will not be expected to provide primary communications in time of emergency, though we can think of instances where this has happened. In some New Brunswick forest fires three years ago, radio amateurs were the only link between fire, police, ambulance and forestry services. Radios used by those agencies were all on different frequencies and without relays by Amateur Radio, they were unable to contact each other. ARES members do expect to provide backup communications which can take the pressure off other communications systems and allow people using those systems to get on with their work.

Most ARES groups are prepared to set up a base station at the scene of an emergency. Most are prepared to operate there and wherever else they are needed for extended periods of time. They are prepared, say, to help track down a badly needed piece of equipment, to contact a family to report on the condition of a person who was injured, or to work with organizations like the

Red Cross that usually have no radio systems of their own.

Most ARES communications takes place on VHF, on the 2-metre (144-148-MHz) band, through repeater stations using frequency modulation (FM), though links can be made with NTS and a special ARES Canada Network which operates on HF (high frequencies, 3-30 MHz) to forward written message communications to anywhere in Canada, the United States or beyond.

A word about repeaters: Most radio amateur have radios in their cars and many own portable transceivers. To increase the range of these units, radio amateurs in every area of Canada have established repeater stations (there were 613 as of 1988 December 31). A repeater, because it is mounted on a high building or tower, can readily receive signals from a wide area. And when it retransmits these signals, because of its high location, they can be heard over a wide area. The result: clean, reliable communications over an area with a radius of 20-50 miles.

Most areas have at least one repeater with an autopatch. These repeaters can be connected into the local telephone system. Thus, an amateur with a mobile or handheld transceiver within range of such a repeater can dial up a telephone number -- the same as he or she would on a telephone at home.

We could say more, but it would be better to examine a specific example. Mississauga 1979 was a chemical spill that required the evacuation of 200,000 thousand people. Amateur participation in this emergency was recognized by both the Government of Ontario and the Red Cross, and is well documented in the article attached as Appendix A. If you've come this far with us, please stop and read the article now. We'll wait for you right here!

Whom should I contact to involve radio amateurs in my emergency preparations?

Contact the CRRL Section Manager or CRRL Section Emergency Coordinator in your part of Canada. Their names and addresses are listed in Appendix B. They can tell you if there is an established ARES group in your area, and if not, provide some leadership in getting one started. For historical reasons that do not imply any animosity towards CRRL, emergency communications in two regions of Canada have developed independently. In British Columbia, independent groups of radio amateurs are registered with the Provincial Emergency Program [illegible]P). In Quebec, radio amateurs, with the assistance of the Quebec governm[illegible] and their provincial Amateur Radio organization, Radio Amateur du Québec, [illegible]ve developed Réseau d'Urgence. In both areas, radio amateurs work to str[illegible] guidelines and the communications they provide meet the same high standa[illegible]at are set for ARES. CRRL supports your involvement with them. Section[illegible]ers in British Columbia and Quebec can tell you whom to contact.

Conclusion

This paper has been long on background and short on specifics -- on exactly how radio amateurs might be involved in an emergency. However, we felt that many of you would not be familiar with Amateur Radio (you may even have confused it with Citizen's Band Radio; they are certainly not the same), and we were anxious to establish our credentials.

If you have dealt with emergencies involving dangerous goods, you will know there is no "typical emergency". Thus, it would have been inappropriate for us to describe the exact role a particular group of radio amateurs might play in a particular emergency. We are confident that radio amateurs, particularly working in CRRL-sponsored ARES groups, can play an important role in your emergency preparations. We hope you will consider using them. HJM

Appendix A

A train derailment and the subsequent explosion and burning of several tank cars was just the beginning of more than 80 hours of emergency operation in Mississauga. *(photo by Pete Martin, compliments Gulf Canada, Ltd.)*

November 10, 1979 — It was a quiet Saturday evening in Mississauga, on the west side of Toronto. The hour approached midnight, as a freight train loaded with chemicals sped through an industrial area near Lake Ontario.

Moments later the train derailed — flames from the twisted wreck reached as high as an apartment building. VE3BEA called his wife to the window of their home in nearby Oakville to observe the glow of the "aurora" in the eastern sky. Strange for this time of year. Their house shook, as tanks of propane began to explode. The realization dawned that they weren't seeing aurora — the Mississauga madness had begun.

By early Sunday morning, officials realized that the train contained tanks of highly toxic chlorine gas and began evacuating people from the immediate area of the wreck. (Chlorine gas was used with deadly effect in World War I and it was leaking into the air in a densely

*298 Warden Ave., Scarborough, ON M1N 3A4
**1393 Bridge Rd., Oakville, ON L6L 2C8

populated area.) The large shopping plaza known as "Square One" became an evacuation center.

At approximately 1300 local time, Ontario Section Emergency Coordinator (SEC) VE3APK contacted the director of Emergency Services, Canadian Red Cross-Ontario division, who advised that as soon as the location of the evacuation center was known, Red Cross would require Amateur Radio Emergency Service (ARES) assistance. At 1630, however, VE3APK was advised that "Square One" itself was now being evacuated! Communications would be required as soon as the new centers were established.

The evacuation area was widening as the wind shifted. Eventually the entire population of the city of Mississauga, a quarter of a million people, would be evacuated.

At 1930, the word came from Red Cross that the International Center in Malton, northwest of Toronto, had been opened for evacuees. Red Cross required a station there, as well as one in downtown Toronto at Red Cross headquarters. As emergency coordinator (EC) for Toronto, VE3GFN was responsible for setting up this station. VE3JPP was dispatched to do this, with assistance from the Pickering ARC. The Pickering Club's call sign, VE3SPC, was used at Red Cross hq. VE3JPP did not emerge from the Red Cross building for three days.

VE3IXB was the brand new EC for the Mississauga area. The operation became his "baby" (with the help of assistant EC VE3HGC and the ARES group) and he had already established radio links with evacuation centers at Streetsville, Brampton and Malton. Think of it: VE3IXB was heading one of the largest operations ever experienced by Canadian amateurs and the ink was barely dry on his EC certificate. What an initiation! The Mississauga ARES was backed by manpower from the Toronto area as well, activated by VE3GFN. VE3IMR, Oshawa EC, was standing by with a task force. The Burlington group had 20 mobiles ready to go where needed and the Hamilton ARES, under EC VE3FCU, was on alert too.

With Amateur Radio communications established at evacuation centers in the Brampton/Streetsville area, it was decided that the Brampton repeater, VE3MHZ, would be used as the main control station, using the Peel ARC call sign VE3PRC. VE3GOL handled a major part of the control duties, which linked all evacuation centers, Red Cross headquarters, and even the disaster site itself.

Health-and-welfare (H & W) inquiries began pouring in soon after the evacuation centers were opened, so it was decided to use a second repeater to handle the overflow of traffic. Thus VE3SKY, the Skyride ARC repeater, was put on emergency service.

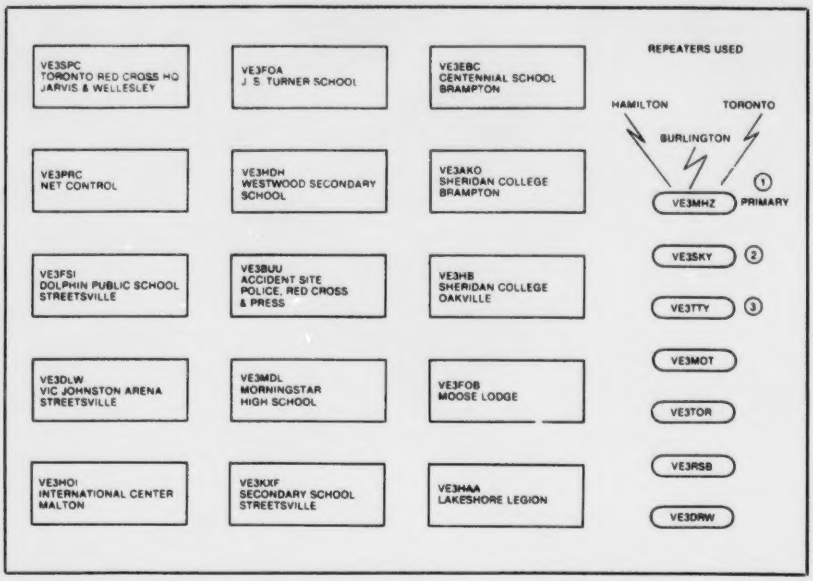

VE3SPC
TORONTO RED CROSS HQ
JARVIS & WELLESLEY
VE3FOA
J. S. TURNER SCHOOL
VE3EBC
CENTENNIAL SCHOOL
BRAMPTON
REPEATERS USED
HAMILTON
TORONTO
BURLINGTON
VE3PRC
NET CONTROL
VE3HDH
WESTWOOD SECONDARY
SCHOOL
VE3AKO
SHERIDAN COLLEGE
BRAMPTON
①
VE3MHZ
PRIMARY
VE3FSI
DOLPHIN PUBLIC SCHOOL
STREETSVILLE
VE3BUU
ACCIDENT SITE
POLICE, RED CROSS
& PRESS
VE3HB
SHERIDAN COLLEGE
OAKVILLE
VE3SKY
②
VE3TTY
③
VE3DLW
VIC JOHNSTON ARENA
STREETSVILLE
VE3MDL
MORNINGSTAR
HIGH SCHOOL
VE3FOB
MOOSE LODGE
VE3MOT
VE3TOR
VE3HOI
INTERNATIONAL CENTER
MALTON
VE3KXF
SECONDARY SCHOOL
STREETSVILLE
VE3HAA
LAKESHORE LEGION
VE3RSB
VE3DRW

Fig. 1 — The Mississauga Emergency Network

Meanwhile, the fires continued to burn — hospitals in the immediate area were evacuated early Sunday afternoon, with patients being transported to Toronto-area hospitals.

On the Scene

VE3FPF was one of the citizens being evacuated from his home near the disaster site. He called in on the repeater and offered to stay in the area, once his family was on the move to safe ground. He reached the spill site and after some persuasion, managed to reach the Red Cross official at the Command Post, where police, fire and government officials were controlling the evacuation and containment. Suddenly Red Cross had a direct ARES link between their Toronto headquarters and the commanders on site. This link was assigned a priority and manned by a rotating shift of operators throughout the entire emergency.

As the evening wore on, the evacuation boundaries widened. At approximately 2200, word was received that the Oakville hospital was to be evacuated as a precautionary measure. VE3GUH, a doctor on the hospital staff, put out a call for assistance. There were 70 ambulances coming to transport patients to Hamilton; it was absolutely necessary to coordinate movement between the hospitals. The telephone systems were overloaded but Amateur Radio was available. VE3FCU arranged the communications links — all went well.

At 2230, the boundary to the west became Maplegrove Avenue in Oakville. An evacuation center for Oakville residents was established at a large school in Burlington; more equipment and operators were supplied by the Burlington/Hamilton ARES. And another center was established at the community college in Oakville.

"This is VE3SPC at Red Cross. We Need a Head Count of Evacuees at All Centers"

By 0600 Monday morning, a total of 12 evacuation centers were in operation, and two command centers plus the net control station were all directly involved. Auxiliary nets were being maintained during the daylight hours. The Burlington ARES group initiated a 75-meter net to handle H & W inquiries. VE3AML activated his COMSONT net on 40 meters and supplied coverage to the entire province. The ONTARS net, which meets daily on 3755 kHz, was also used extensively.

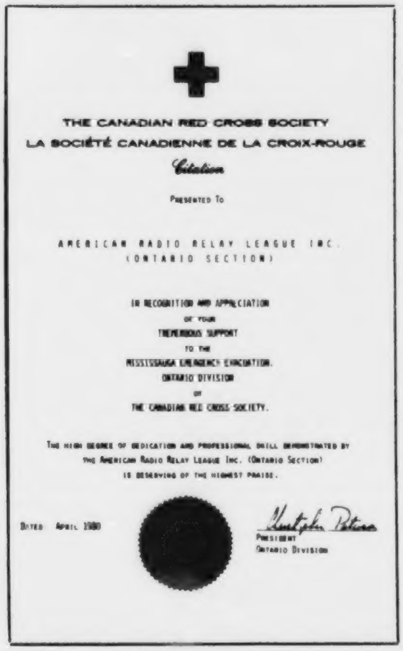
By Tuesday evening, some 56 hours after beginning, the scope of the operation had crested and the first tentative indications of a return home by evacuees appeared. Some centers were closing, the remaining people and supplies moved to other centers. Now the hams were assisting with transport problems, finding out who needed a bus and trying to minimize vehicular traffic, and related tasks.

By Wednesday morning, about 150,000

Charles H. "Chuck" Powers, VE3APK, Ontario SEC at the controls during the recent Mississauga accident. *(photo by Scott Powers, Oakville* Journal Record*)*

evacuees were permitted to return home. VE3PRC was still active but handled little traffic. A call to the Red Cross affirmed that the services of ARES were still needed. The circuits were kept open, despite a shortage of personnel. The day wore on and the boundaries began, at last, to shrink. At 1930 three centers were still in operation. Word was received that the railway involved would billet all remaining evacuees in Toronto hotels free of charge until they could return home. ARES provided a head count for the Red Cross and was able to advise transportation needs. A final tally was passed and the buses started to roll. At 1945 the following message was sent on all nets in operation:

199 R VE3APK 68 OAKVILLE ON 0045Z NOV. 15
TO: ALL ONTARIO AMATEURS AND PARTICIPANTS MISSISSAUGA EVACUATION CRISIS
ONTARIO DIVISION CANADIAN RED CROSS WISH TO EXTEND THEIR SINCERE APPRECIATION AND ADMIRATION FOR THE SUPPORT GIVEN TO THE SOCIETY DURING THE MISSISSAUGA EVACUATION CRISIS X
THE HIGH DEGREE OF DEDICATION AND PROFESSIONAL SKILL EVIDENCED BY ALL PERSONNEL OF ARRL ONTARIO SECTION IS DESERVING OF THE HIGHEST PRAISE X
AS OF 2359 EST 14 NOVEMBER 79 THE OPERATIONS REQUIRING THE SERVICES OF ARRL ONTARIO SECTION ARE ENDED X
BRIGADIER GENERAL J. F. WESTHEAD - MBE ED CD (RETIRED) CHAIRMAN - EMERGENCY SERVICES
MR. KEN MCBRIDE - DIRECTOR - EMERGENCY SERVICES
MRS. MILLIE BLAIR - ASSISTANT DIRECTOR -EMERGENCY SERVICES
CANADIAN RED CROSS - ONTARIO DIVISION



THE CANADIAN RED CROSS SOCIETY
LA SOCIÉTÉ CANADIENNE DE LA CROIX-ROUGE
Citation
PRESENTED TO

AMERICAN RADIO RELAY LEAGUE INC.
(ONTARIO SECTION)

IN RECOGNITION AND APPRECIATION
OF YOUR
TREMENDOUS SUPPORT
TO THE
MISSISSAUGA EMERGENCY EVACUATION.
ONTARIO DIVISION
OF
THE CANADIAN RED CROSS SOCIETY.

THE HIGH DEGREE OF DEDICATION AND PROFESSIONAL SKILL DEMONSTRATED BY
THE AMERICAN RADIO RELAY LEAGUE INC. (ONTARIO SECTION)
IS DESERVING OF THE HIGHEST PRAISE.

DATED APRIL 1980

PRESIDENT
ONTARIO DIVISION

Ontario Division Canadian Red Cross presented this certificate to officials of the Ontario Section of the League to show its appreciation for the excellent communications provided by Amateur Radio operators during the November 1979 Mississauga evacuation.

Some 80 hours had elapsed since the first call for assistance was received from Red Cross. A total of 255 amateurs volunteered their services from across the province, 174 were actively involved on 2 meters, others were on standby or operated the hf bands. Twelve repeaters were used at various times and nine ARES groups were active.

At 2359, the following message was read by VE3GOL:

943 R VE3APK 32 OAKVILLE ON 2359 NOV. 15/79
NET BULLETIN - VE3PRC - MISSISSAUGA EMERGENCY NET
ON BEHALF OF THE ONTARIO SECTION OF ARRL WE EXTEND SINCERE THANKS TO ALL AMATEURS FOR THEIR SUPERB OPERATION X YOU HAVE DEMONSTRATED THE TRUE SPIRIT OF THE AMATEUR RADIO FRATERNITY 73.
LARRY VE3GT SCM
CHUCK VE3APK SEC
NOREEN VE3GOL STM
THIS EMERGENCY NET IS OFFICIALLY CLOSED.

November 11 is Remembrance Day in Canada, when we honor those who gave their lives during two world wars. It will be a day to remember in Mississauga for years to come.

Appendix B

The Canadian Radio Relay League, Inc.

President: Thomas B, J. Atkins, VE3CDM, 55 Havenbrook Blvd
Willowdale, ON M2J 1A7 (416-494-8721)

General Manager: Raymond Staines, VE3ZJ, CRRL Headquarters, Box 7009, Stn E
London, ON N5Y 4J9 (519-660-1200)

Field Services Manager: Jack Strangleman, VE3GV, 512 Pinetree Ave
London, ON N6H 3N1 (519-471-2301)

Section Managers of the CRRL

Alberta: William Gillespie, VE6ABC, 10932 68th Ave
Edmonton, AB T6H 2C1 (403-438-2510)

British Columbia: Ernest Savage, VE7FB, 4553 West 12th Ave
Vancouver, BC V6R 2R4 (604-224-5226)

Manitoba: Jack Adams, VE4JA, 227 Davidson Ave E
Dauphin, MB R7M 2Z4 (204-638-9270)

Maritimes-Newfoundland: Carl Anderson, VE1BQO, 25 Lawnsdale Dr
Dartmouth, NS B3A 2N1 (902-469-9756)

Ontario: Larry Thivierge, VE3GT, 34 Bruce St W
Renfrew, ON K7V 3W1 (613-432-5967)

Quebec: Harold Moreau, VE2BP, 80 rue Principale, St-Simon Co
Bagot, PQ J0H 1Y0 (514-798-2173)

Saskatchewan: Bruce Rattray, VE5RC, 128 Durham Dr
Regina, SK S4S 4Z2 (306-584-2059)

Section Emergency Coordinators of the CRRL

Alberta: Ken Oleke, VE6AFO, 7126 Temple Dr NE
Calgary, AB T1Y 4E7 (604-224-5226)

British Columbia: contact Section Manager

Manitoba: Terry Ryshak, VE4VR, 101 5th Ave NW
Portage la Prairie, MB R1N 0E2 (204-857-8918)

Maritimes-Newfoundland: contact Section Manager

Ontario: Jack Strangleman, VE3GV, 512 Pinetree Ave
London, ON N6H 3N1 (519-471-2301)

Quebec: Yves Chapleau, VE2LYC, 11122 Boulevard St-Vital
Montreal, PQ H1H 4T6 (514-325-9172)

Saskatchewan: Tom Hill, VE5TH, 26 Hammond Rd
Regina, SK S4R 3C6 (306-543-8473)

Bibliography

Riley, Michael R, *The Emergency Coordinator's Manual*, American Radio Relay League, Newington, Connecticuit, 1984.

Emergency Response Communications

W.F. Kerr
Department of Communications
Ottawa, Ontario

Abstract

The paper explores the current situation concerning the handling of dangerous goods, particularly with regard to the need for situation control during emergencies. The requirement for emergency response communications systems is discussed, different systems outlined, and illustrations of satellite-based systems that may have application in emergency response integrated systems planning are given. A recommendation for field trial development is included.

Introduction

Dangerous goods are no longer the concern of only a few. The production, distribution, use and disposal of dangerous goods are public concerns now, and of ever increasing importance. The pressure of public concern bears heavily on those who have direct responsibility for the handling of dangerous goods. The response to this pressure has to be more control. Those responsible for dangerous goods must be in control, and be seen to be in control, of all aspects of dangerous goods handling. Whenever this is not the case, responsibility for control is lifted from those who should be best equipped for the task, and given to others who, more often than not, rely on more and more regulation for purposes of control. As more regulations are enforced, public awareness goes up, and the pressure mounts.

Pressures on those who handle dangerous goods are increasing for other reasons, too. As society becomes richer, more complex and sophisticated, the demand for more and different products increases the demand for more and different dangerous goods. So, while all activities associated with the handling of dangerous goods are expanding, tightening regulation is constraining those activities, and the whole situation is spot-lighted by a sometimes harsh public eye.

Whenever dangerous goods are handled, the potential for an emergency situation exists. When an emergency occurs, response to it must be quick and certain. Response preparedness and situation control are the key factors in successful response. Communications among all members of the emergency response team must be good. Reliable telecommunications links are essential. The establishment and maintenance of high-quality telecommunications links among the sited locations in the chain of dangerous goods handling activities is the product of good planning, engineering and management. It is not necessarily difficult. It does become difficult, however, during the transportation phase of dangerous goods handling. It is during this phase also that the dangerous goods are most vulnerable to outside interference, for that is when interfaces with other parts of society are continuous. The development of effective transportation emergency response communications systems is a continuing priority.

Telecommunications Systems

Telecommunications systems for use in transportation may be categorized into three groups: fixed, transportable and mobile. An example of a fixed system is the switched telephone network, which provides communications access at stops along the route for many parts of the country. An example of a transportable system is the highly transportable telephony satellite earth station, which can be set up in minutes at any stop. This earth terminal works through a communications satellite to a master earth station which is connected to the command centre. Mobile systems are best exemplified by the two-way radio systems now in common use on fire and other emergency vehicles. Each of these systems has its rightful place in transportation emergency response. The terrestrial telephone system is reliable and cheap, but it requires a stop and is not available in all parts of the country. The satellite telephone system is reliable and available in all parts of the country, but at its current stage of development it is relatively expensive and almost always requires a stop. The terrestrial radio system is relatively inexpensive and can be used on the move, but it is not available in all parts of the country and has some problems with reliability. All three systems continue to expand and develop, and therefore offer to emergency response planners some opportunities to influence the development of telecommunications technology and systems more suited to their particular needs. The very rapid advances in satellite technology and applications indicate to all communications systems planners the necessity for them to give careful consideration to satellite-based solutions to their problems.

Satellite Systems for Emergency Response

The communications satellite has revolutionized telecommunications in the world. It is a relatively recent triumph of technology. Arthur C. Clarke conceived the idea in 1945; the first satellite, the U.S.S.R. Sputnik, was a small spacecraft (non-communications) in low earth orbit, launched in October 1957: Canada launched its first satellite, Alouette I, in September of 1962. Alouette I was not a communications satellite - it was a scientific satellite in low earth orbit that was designed to study the ionosphere to find out what could be done to overcome the horrendous interference caused to radio communications by disturbances in that electrified layer of the world's atmosphere. Alouette I and its successors, Alouette II and ISIS I and II, helped solve some of the problems of terrestrial radio communications, but their real mark in scientific history was their confirmation that a communications satellite, along the lines envisaged by Clarke, was the only viable answer for reliable telecommunications throughout Canada. In November 1972, Canada launched its first ANIK satellite, and became the first country in the world with a domestic geostationary communications satellite system. Since then, Canada has launched nine other communications satellites, and now boasts two domestic systems: a C-band (6/4 GHz) system with the two ANIK-D satellites, and a Ku-band (14/12 GHz) system with three ANIK-C satellites.

So far, Canadian communications satellites have been in the "fixed" services category, i.e: not designed for direct broadcasting or mobile services. However, we have used them extensively for broadcasting (satellite-to-cable and direct-to-home) and in some quasi-mobile service applications. It is in this area of quasi-mobile, as well as mobile, service applications development that emergency response systems potential exists. The Federal Department of Communications (DOC), in partnership with other public sector and private organizations, has conducted several pilot projects and field trials to test new technology and service delivery concepts, and some of these may have application in emergency response system planning.

A satellite news gathering (SNG) transportable TV earth terminal was developed for the CBC. The terminal was trailer mounted, to be towed behind a station wagon or electronic news gathering (ENG) truck. Once on site, the terminal could be operational in approximately twenty minutes, transmitting network-quality television back to master control. The unit was configured to be self-contained, so it could broadcast from any part of Canada it could access. The SNG terminal was commercialized by Telesat Canada, and now versions of it can be seen in many countries of the world.

A stabilized off-shore terminal was developed for use on semi-submersible oil-drilling rigs in Hibernia, to maintain reliable communications no matter what sea-state existed. This terminal was commercialized by SPAR Aerospace as the "Sparmarine" product offering, the off-shore carrier service is available from Newfoundland Telephone Company, and a telemedicine package service is offered by Memorial University of Newfoundland.

A highly-transportable telephony terminal was developed for quasi-mobile applications, and has been field tested by the Armed Forces in Labrador and northern Ontario, by the Government of Ontario, Ontario Hydro, CNCP and others. It has proven very useful in situations requiring quick deployment, such as forest fire-fighting, and has been commercialized by Skywave Electronics. The terminal has been dubbed the "suitcase" terminal because of its size and shape when folded for transport. The current model operates in Ku-band, but a C-band version will be built in the near future for use in northern regions, and an "attache case" version is under development. The "attache case" terminal will operate in L-band, the band to be used in Canada's Mobile Satellite (MSAT).

MSAT will be launched in 1993, and will provide mobile radio and data services throughout Canada. The service should be relatively inexpensive, and highly reliable. Emergency response systems could be major beneficiaries of MSAT. Pre-launch trials have begun, with an air ambulance trial underway in Ontario. Two-way data services trials, at sea involving fishing boats and on land involving trucks, will start in the near future.

Conclusion

Emergency response planners are faced with ever-increasing needs to improve communications. One idea that could be adopted in so doing involves participation in field trials of new telecommunications technology, systems and services, a process which has proven effective in other areas of applications development. The process, developed by DOC, is user-driven, i.e: the technology, system and service is designed/modified in accordance with the specific needs of the user - it is not a "common" service or product. This custom-built approach to the development of new and improved communications services is recommended to those responsible for emergency response system planning.

RECENT ADVANCES AT THE UK NATIONAL CHEMICAL EMERGENCY CENTRE

David S King

Deputy Manager, National Chemical Emergency Centre, Harwell, United Kingdom

INTRODUCTION

The United Kingdom National Chemical Emergency Centre (NCEC) at Harwell, was established in 1973 by the Government's Department of the Environment and the Home Office. In collaboration with the Chemical Industries Association (CIA), the Centre plays a key rôle in the UK Chemical Industries Scheme for assistance in Freight Emergencies (CHEMSAFE). The Centre provides advice and/or assistance to the public emergency services, for chemical transport incidents, when the information required for control of the incident is not available from the manufacturer or supplier of the product involved. This can occur for example when drums of chemicals are found at the roadside or have been washed up on beaches. The Centre has a telephone service manned 24 hours a day by a team of technically qualified staff who are always available to offer advice and/or assistance.

To enable this service to be provided effectively it is necessary to have a large amount of chemical information readily available. This must, of course, cover pure chemicals and trade-name products. In collaboration with the Chemical Industries Association, the NCEC has established close links with the UK chemical industry and has a vast collection of data on chemicals being used and transported throughout the country. These data are constantly being updated.

To back up this information a large collection of literature has been obtained ranging from chemical data books, national and international trade directories to current legislative documents (see figure 1).

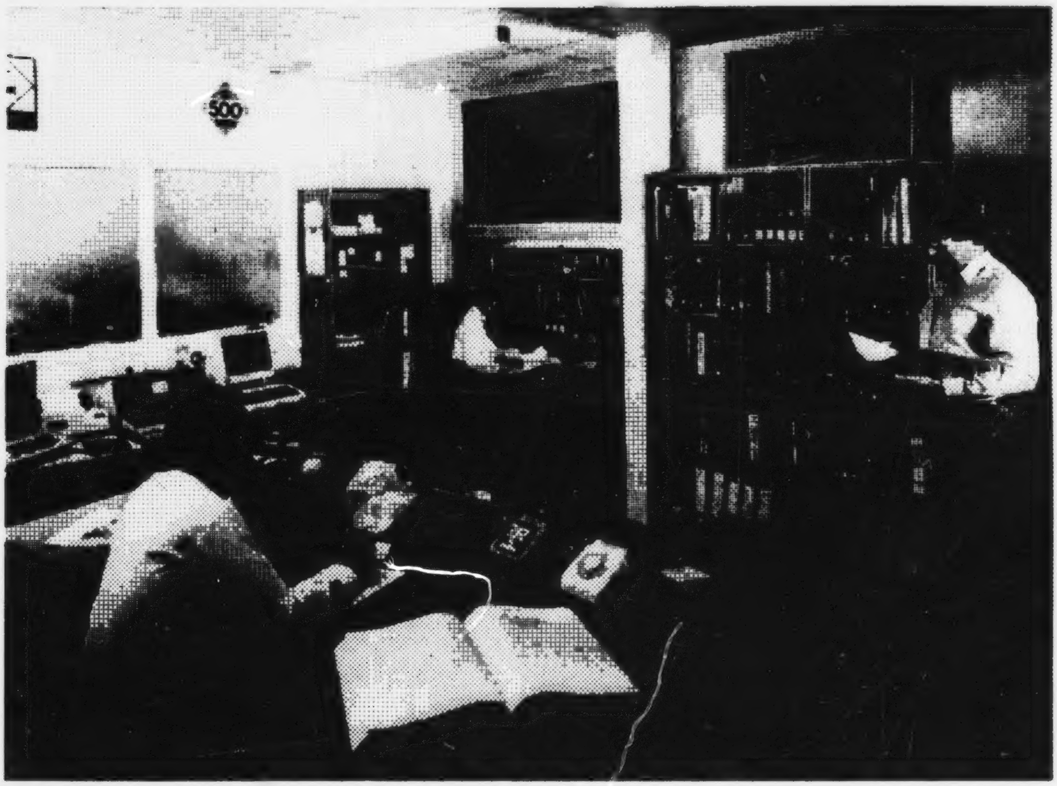


Figure 1. An emergency call in the control room of the National Chemical Emergency Centre

CHEMDATA

To utilise effectively such a large amount of information a computer database, running on a mainframe computer was established. For a trial period this large textual database, called HAZFILE, was available to fire services, allowing them to dial-in via a telephone link and search the system for the required information. Due to the costs involved and some early technical problems it was soon realised that this type of system did not satisfy an emergency response situation and a new database, running on a microcomputer held in a brigade's own control room was developed. This database, called CHEMDATA (Chemical Hazard Evaluation using a Microcomputer accessed DATAbank), offered instant access to clear, concise information designed for dealing with the first few minutes of a chemical accident. The system was quickly adopted by a majority of the UK fire brigades, who found that the simple user-interface enabled non-technical operators to search for what could be complex chemical names, identify the chemical in the database and provide the officers at the incident with control and clean-up information specific to the chemical involved.

Since the first operational release of CHEMDATA in 1982, many developments have taken place. The NCEC actively encourages all users to provide feedback on their use of the system and suggest any improvements that they think could be made. Taking this into account, and making use of the most up-to-date advances in micro-computer technology, the software and database structure are constantly reviewed. April 1988 saw a major rewrite of the custom written software, bringing in new features, including a much simpler user input system, the introduction of searchable CAS numbers (Chemical Abstract Service numbers) and the combination of part name and part UN number searches (useful for when drum or placard labels are only partially readable). As an example, suppose an incident involves a liquid, leaking from a drum, by the roadside, with the label partly obliterated. The only information readable is that shown infigure 2.

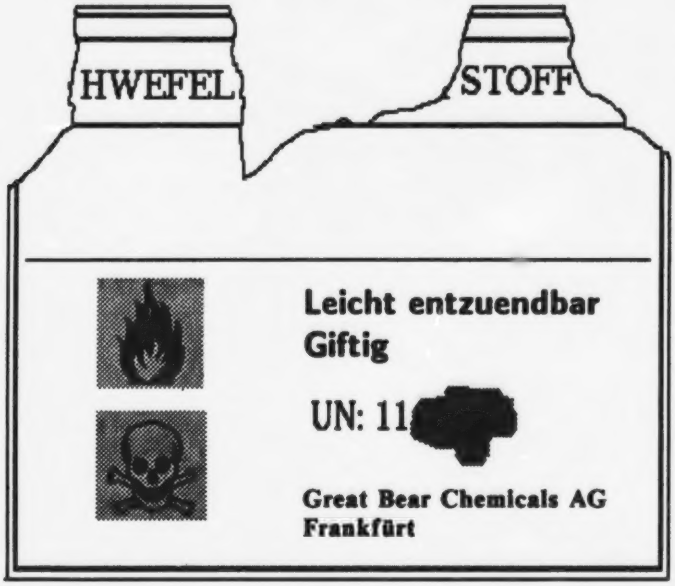
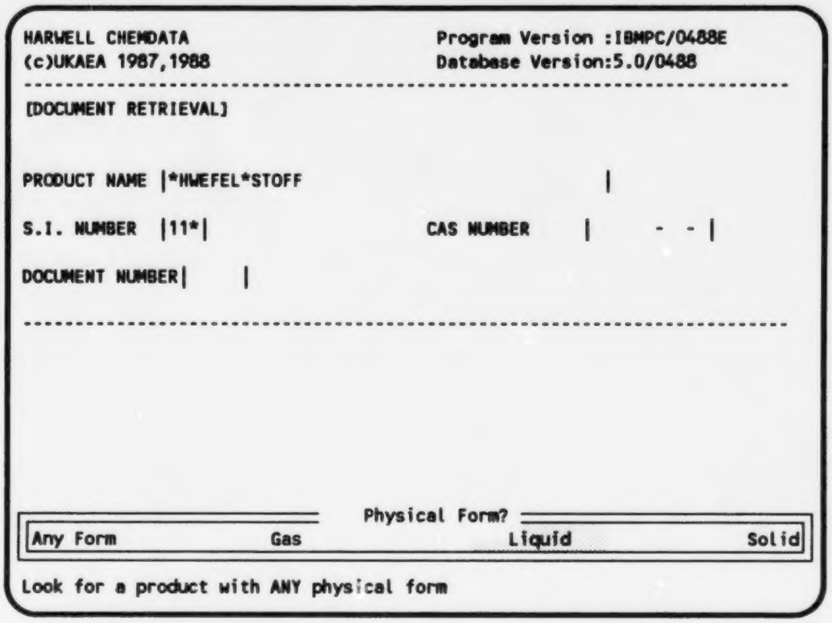


Figure 2. Partly unreadable label from drum of chemicals found at roadside

This information is entered into the appropriate fields in CHEMDATA (figure 3). Figure 4 shows that one reference has been found which fits this criteria, and on displaying the first page of the document (figure 5), it can be seen that the retrieved name: SCHWEFELKOHLENSTOFF is a German name (the "D" signifying Deutsch) for CARBON DISULPHIDE (a full print-out of this document is shown in figure 6).



```
HARWELL CHEMDATA                         Program Version :IBMPC/0488E
(c)UKAEA 1987,1988                       Database Version:5.0/0488
-------------------------------------------------------------------
[DOCUMENT RETRIEVAL]

PRODUCT NAME |*HWEFEL*STOFF                              |

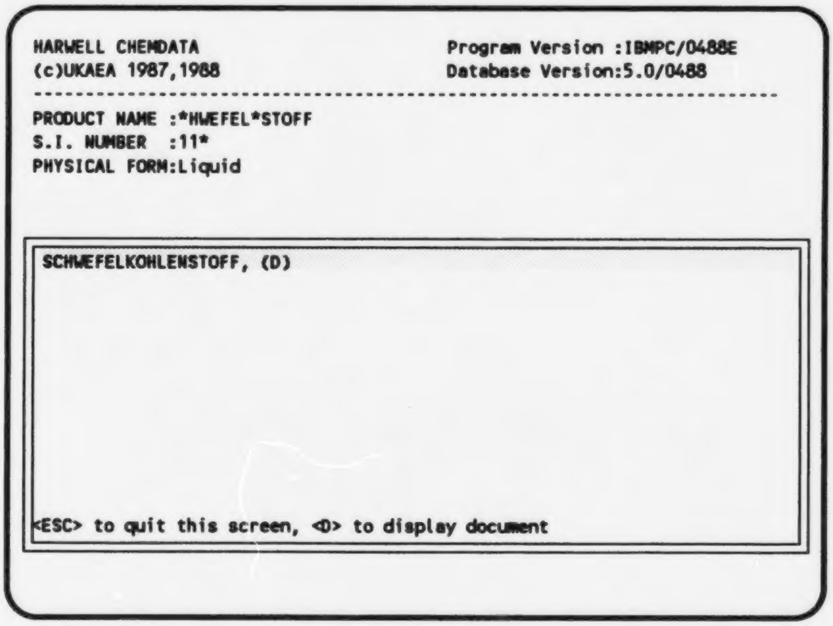
S.I. NUMBER  |11*|                     CAS NUMBER    |     - - |

DOCUMENT NUMBER|     |
-------------------------------------------------------------------

                         Physical Form?
Any Form              Gas                   Liquid                Solid

Look for a product with ANY physical form
```

Figure 3. CHEMDATA input screen

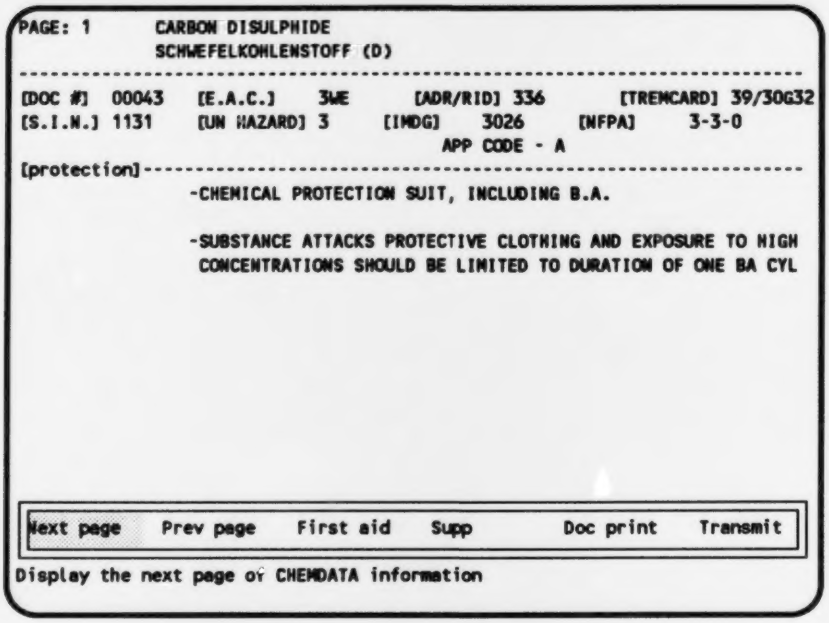


```
HARWELL CHEMDATA                         Program Version :IBMPC/0488E
(c)UKAEA 1987,1988                       Database Version:5.0/0488
-------------------------------------------------------------------
PRODUCT NAME :*HWEFEL*STOFF
S.I. NUMBER  :11*
PHYSICAL FORM:Liquid

 SCHWEFELKOHLENSTOFF, (D)

<ESC> to quit this screen, <D> to display document
```

Figure 4. CHEMDATA retrieved list display

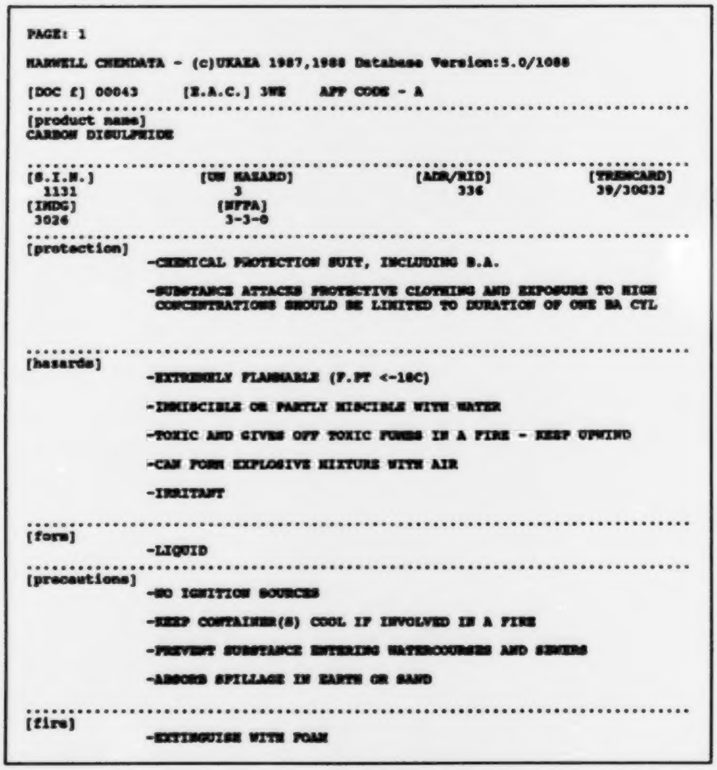


```
PAGE: 1      CARBON DISULPHIDE
             SCHWEFELKOHLENSTOFF (D)
-----------------------------------------------------------------------
[DOC #]  00043   [E.A.C.]    3WE      [ADR/RID] 336       [TREMCARD] 39/30G32
[S.I.N.] 1131    [UN HAZARD] 3     [IMDG]    3026     [NFPA]      3-3-0
                                          APP CODE - A
[protection]-----------------------------------------------------------
                 -CHEMICAL PROTECTION SUIT, INCLUDING B.A.

                 -SUBSTANCE ATTACKS PROTECTIVE CLOTHING AND EXPOSURE TO HIGH
                  CONCENTRATIONS SHOULD BE LIMITED TO DURATION OF ONE BA CYL
```

```
Display the next page of CHEMDATA information
```

Figure 5. First page of CHEMDATA information



```
PAGE: 1

HARWELL CHEMDATA - (c)UKAEA 1987,1988 Database Version:5.0/1088

[DOC £] 00043     [E.A.C.] 3WE    APP CODE - A
.......................................................................
[product name]
CARBON DISULPHIDE

.......................................................................
[S.I.N.]            [UN HAZARD]                [ADR/RID]            [TREMCARD]
  1131                   3                        336                39/30G32
[IMDG]                [NFPA]
 3026                  3-3-0
.......................................................................
[protection]
              -CHEMICAL PROTECTION SUIT, INCLUDING B.A.

              -SUBSTANCE ATTACKS PROTECTIVE CLOTHING AND EXPOSURE TO HIGH
               CONCENTRATIONS SHOULD BE LIMITED TO DURATION OF ONE BA CYL


.......................................................................
[hazards]
              -EXTREMELY FLAMMABLE (F.PT <-10C)

              -IMMISCIBLE OR PARTLY MISCIBLE WITH WATER

              -TOXIC AND GIVES OFF TOXIC FUMES IN A FIRE - KEEP UPWIND

              -CAN FORM EXPLOSIVE MIXTURE WITH AIR

              -IRRITANT

.......................................................................
[form]
              -LIQUID
.......................................................................
[precautions]
              -NO IGNITION SOURCES

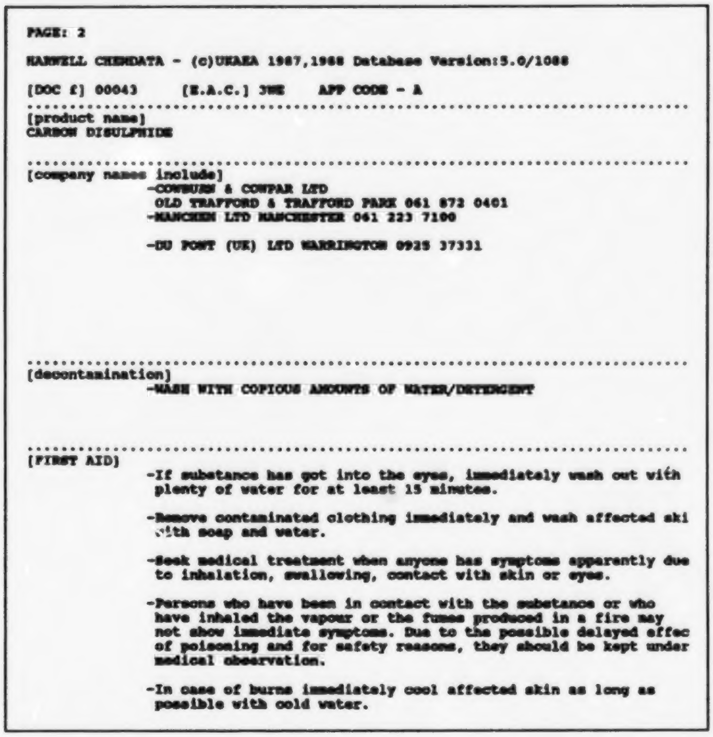
              -KEEP CONTAINER(S) COOL IF INVOLVED IN A FIRE

              -PREVENT SUBSTANCE ENTERING WATERCOURSES AND SEWERS

              -ABSORB SPILLAGE IN EARTH OR SAND

.......................................................................
[fire]
              -EXTINGUISH WITH FOAM
```

Figure 6a. Page 1 of printed output from CHEMDATA



```
PAGE: 2

HARWELL CHEMDATA - (c)UKAEA 1987,1988 Database Version:5.0/1088

[DOC £] 00043     [E.A.C.] 3WE    APP CODE - A
.....................................................................
[product name]
CARBON DISULPHIDE

.....................................................................
[company names include]
                -COWBURN & COWPAR LTD
                 OLD TRAFFORD & TRAFFORD PARK 061 872 0401
                -MANCHEM LTD MANCHESTER 061 223 7100

                -DU PONT (UK) LTD WARRINGTON 0925 37331





.....................................................................
[decontamination]
                -WASH WITH COPIOUS AMOUNTS OF WATER/DETERGENT


.....................................................................
[FIRST AID]
                -If substance has got into the eyes, immediately wash out with
                 plenty of water for at least 15 minutes.

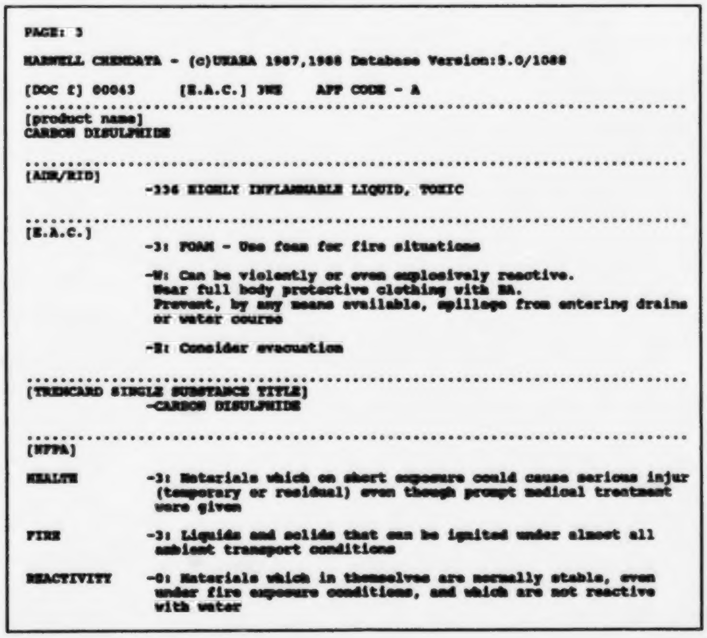
                -Remove contaminated clothing immediately and wash affected ski
                 with soap and water.

                -Seek medical treatment when anyone has symptoms apparently due
                 to inhalation, swallowing, contact with skin or eyes.

                -Persons who have been in contact with the substance or who
                 have inhaled the vapour or the fumes produced in a fire may
                 not show immediate symptoms. Due to the possible delayed effec
                 of poisoning and for safety reasons, they should be kept under
                 medical observation.

                -In case of burns immediately cool affected skin as long as
                 possible with cold water.
```

Figure 6b. Page 2 of printed output from CHEMDATA



```
PAGE: 3

HARWELL CHEMDATA - (c)UKAEA 1987,1988 Database Version:5.0/1088

[DOC £] 00043     [E.A.C.] 3WE    APP CODE - A
.....................................................................
[product name]
CARBON DISULPHIDE

.....................................................................
[ADR/RID]
                -336 HIGHLY INFLAMMABLE LIQUID, TOXIC

.....................................................................
[E.A.C.]
                -3: FOAM - Use foam for fire situations

                -W: Can be violently or even explosively reactive.
                 Wear full body protective clothing with BA.
                 Prevent, by any means available, spillage from entering drains
                 or water course

                -E: Consider evacuation

.....................................................................
[TREMCARD SINGLE SUBSTANCE TITLE]
                -CARBON DISULPHIDE

.....................................................................
[NFPA]

HEALTH          -3: Materials which on short exposure could cause serious injur
                 (temporary or residual) even though prompt medical treatment
                 were given

FIRE            -3: Liquids and solids that can be ignited under almost all
                 ambient transport conditions

REACTIVITY      -0: Materials which in themselves are normally stable, even
                 under fire exposure conditions, and which are not reactive
                 with water
```

Figure 6c. Page 3 of printed output from CHEMDATA

Once a reference to the substance in question has been found in CHEMDATA the information has then to be relayed to the incident scene. Talking the information over a radio link can be laborious and sometimes inaccurate. CHEMDATA now has the facility for transmitting the information directly from the control room to the incident itself using the TRANSMIT facility. This allows any one of a multitude of transmission systems including radio, microwave or fax to be "plugged in" to CHEMDATA enabling the retrieved document to be printed out on a portable printer carried in the cab of the vehicle attending the incident. This facility is now being used by many CHEMDATA users.

Making use of the very latest technology, CHEMDATA has also been released on CD-ROM (Compact Disk-Read Only Memory). Along with the German HOMMEL database and the Swiss Einsatzakten system the CD-ROM is only available in German at present. Having CHEMDATA on CD-ROM also means that a portable computer with a CD reader may be carried in the cab of an incident vehicle at all times, enabling the information to be instantly available.

CHEMDATA currently contains approximately 60,000 names (both pure chemicals and trade names) and is used by fire, police, ambulance and port and water authorities as well as road hauliers, health authorities and airports. Is is currently being used in the UK, Germany, Australia, Africa, Saudi Arabia, Dubai, Sweden, New Zealand, Hong Kong, United States of America and Ireland.

TREMCARDS

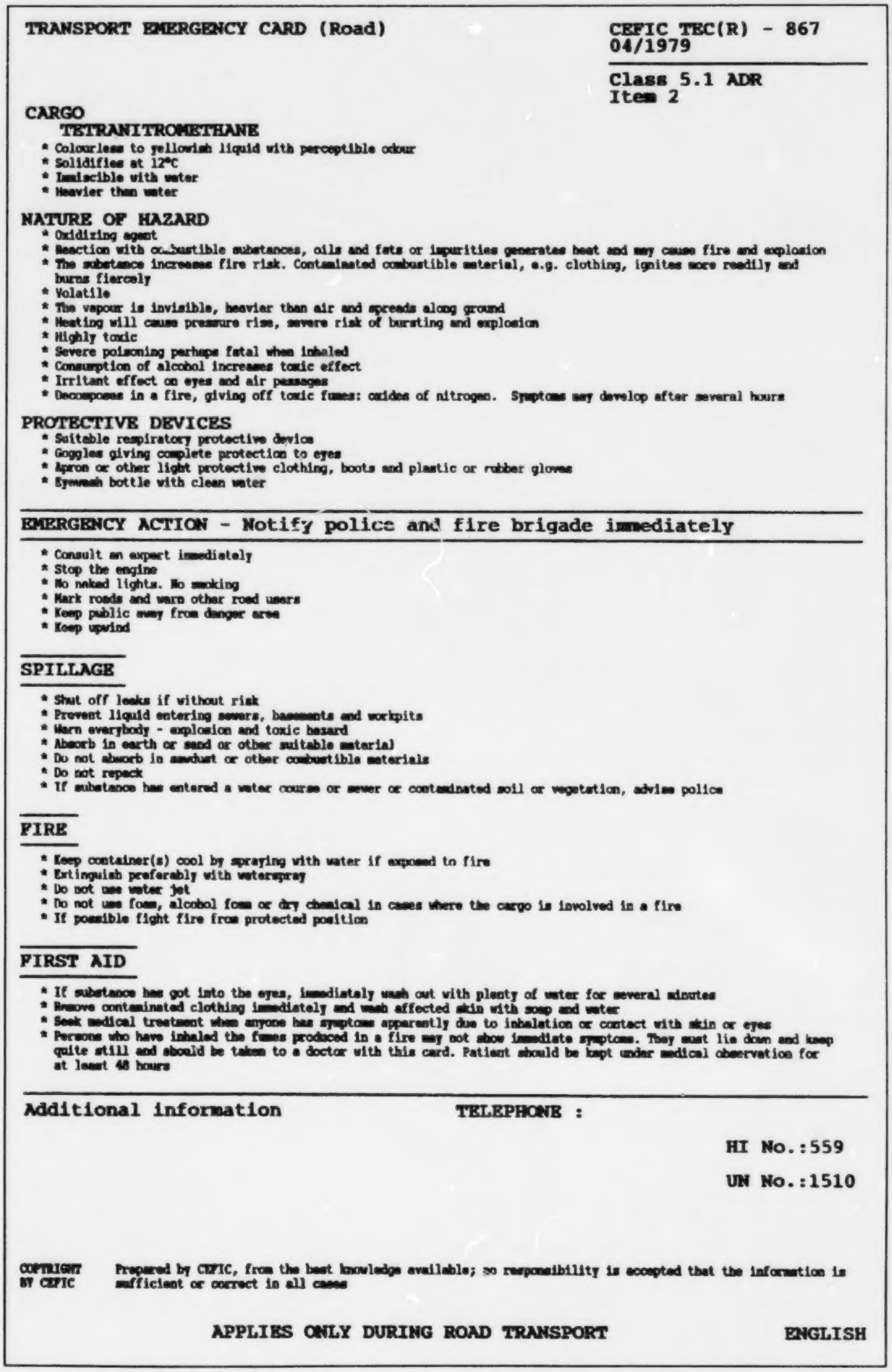
One of the requirements of the European Agreement, ADR, for the international road transport of dangerous goods, is to carry "written instructions" in the cab of a vehicle transporting such a classified material. This information must be carried in the languages of the countries of origin and destination of the load, and in the languages of all the countries through which the load passes. For many years this requirement has been fulfilled by the use of CEFIC (European Council of Chemical Manufacturers Federations) Transport Emergency Cards, commonly known as Tremcards[4].

Tremcards are intended to provide drivers of road vehicles conveying dangerous substances with the necessary 'written instructions' about the hazardous nature of the cargo and emergency actions in the event of an accident.

Two types of Tremcards are available - single substance texts and generic group texts - the latter being based on current ADR classifications and designed to cover a range of chemical products. The name of the product being conveyed is intended to be inserted by the consignor and approved deletions/amendments may be made to the text, thus enabling the customised group text to resemble a single substance card.

CEFIC are constantly updating the texts of Tremcards to take into account changes in ADR and current thinking on the emergency response to chemical incidents. It has always been somewhat of a problem to keep the users of such Tremcards up to date with the latest texts. This problem has now been resolved with the computerisation of Tremcards. A database of all official single substance and group texts, together with all the sentences used on such cards in the languages of CEFIC member countries, has been developed by the NCEC. The package, running on commonly available "PC" type micro computers, allows the user to select a Tremcard, either by its number or name, add the substance name to the card, select the various options allowed by CEFIC (e.g. miscible/immiscible with water), add an emergency telephone number and any other additional information the user deems useful to the emergency services. These data are then stored in the database for recall at any subsequent time. The card can be printed in any one, or a selection of the languages supported.

The sentence and data files are updated annually, enabling users to be kept as up-to-date as possible and ensuring that the very latest information is available to the emergency services in the event of an incident. Figure 7 shows a single substance card and a customised group text is shown in figure 8.



TRANSPORT EMERGENCY CARD (Road)

CEFIC TEC(R) - 867
04/1979

Class 5.1 ADR
Item 2

CARGO

TETRANITROMETHANE

- Colourless to yellowish liquid with perceptible odour
- Solidifies at 12°C
- Immiscible with water
- Heavier than water

NATURE OF HAZARD

- Oxidizing agent
- Reaction with combustible substances, oils and fats or impurities generates heat and may cause fire and explosion
- The substance increases fire risk. Contaminated combustible material, e.g. clothing, ignites more readily and burns fiercely
- Volatile
- The vapour is invisible, heavier than air and spreads along ground
- Heating will cause pressure rise, severe risk of bursting and explosion
- Highly toxic
- Severe poisoning perhaps fatal when inhaled
- Consumption of alcohol increases toxic effect
- Irritant effect on eyes and air passages
- Decomposes in a fire, giving off toxic fumes: oxides of nitrogen. Symptoms may develop after several hours

PROTECTIVE DEVICES

- Suitable respiratory protective device
- Goggles giving complete protection to eyes
- Apron or other light protective clothing, boots and plastic or rubber gloves
- Eyewash bottle with clean water

EMERGENCY ACTION - Notify police and fire brigade immediately

- Consult an expert immediately
- Stop the engine
- No naked lights. No smoking
- Mark roads and warn other road users
- Keep public away from danger area
- Keep upwind

SPILLAGE

- Shut off leaks if without risk
- Prevent liquid entering sewers, basements and workpits
- Warn everybody - explosion and toxic hazard
- Absorb in earth or sand or other suitable material
- Do not absorb in sawdust or other combustible materials
- Do not repack
- If substance has entered a water course or sewer or contaminated soil or vegetation, advise police

FIRE

- Keep container(s) cool by spraying with water if exposed to fire
- Extinguish preferably with waterspray
- Do not use water jet
- Do not use foam, alcohol foam or dry chemical in cases where the cargo is involved in a fire
- If possible fight fire from protected position

FIRST AID

- If substance has got into the eyes, immediately wash out with plenty of water for several minutes
- Remove contaminated clothing immediately and wash affected skin with soap and water
- Seek medical treatment when anyone has symptoms apparently due to inhalation or contact with skin or eyes
- Persons who have inhaled the fumes produced in a fire may not show immediate symptoms. They must lie down and keep quite still and should be taken to a doctor with this card. Patient should be kept under medical observation for at least 48 hours

Additional information **TELEPHONE :**

HI No.:559

UN No.:1510

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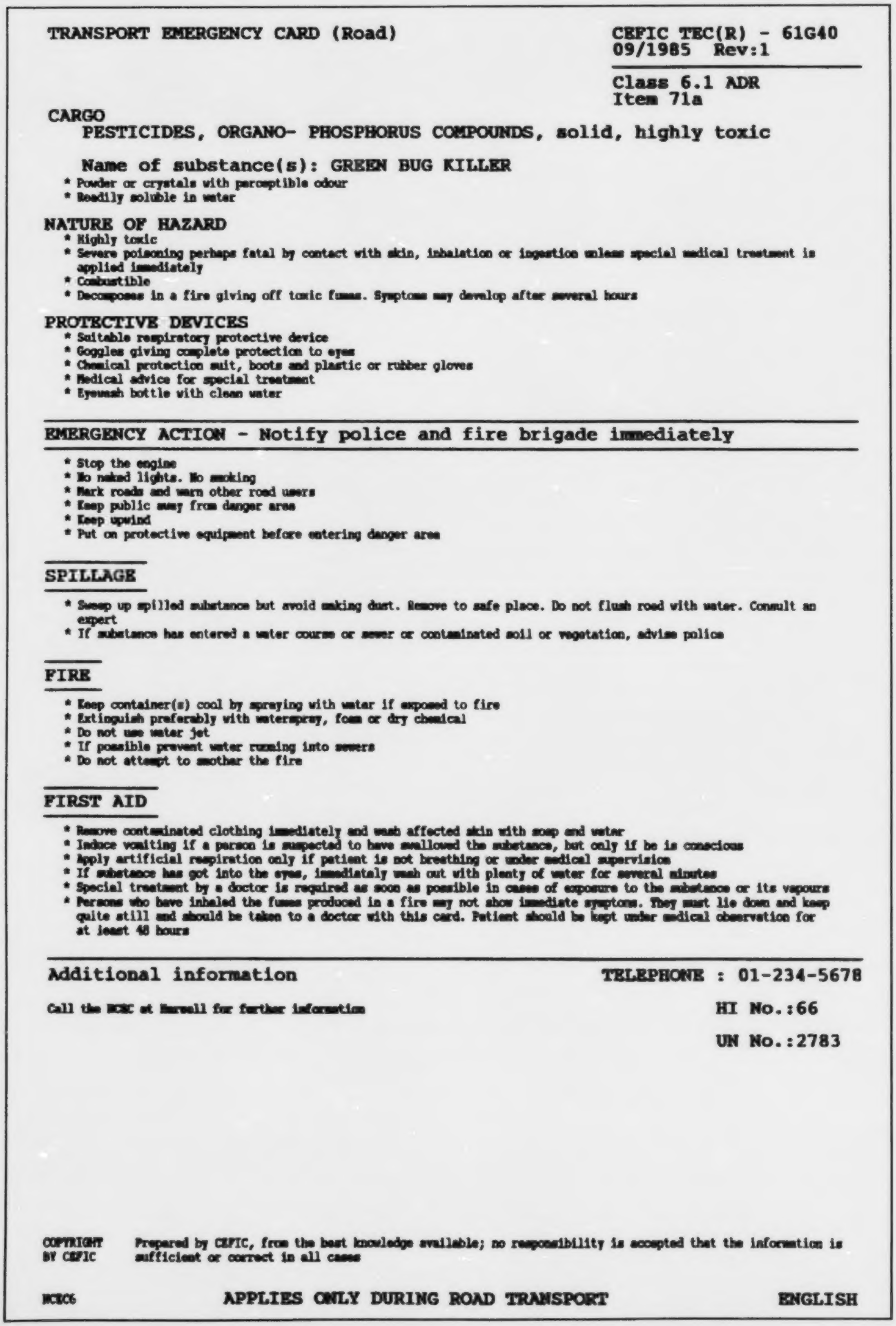
APPLIES ONLY DURING ROAD TRANSPORT **ENGLISH**

Figure 7. Example of a single substance CEFIC TREMCARD



TRANSPORT EMERGENCY CARD (Road)

CEFIC TEC(R) - 61G40
09/1985 Rev:1

Class 6.1 ADR
Item 71a

CARGO

PESTICIDES, ORGANO- PHOSPHORUS COMPOUNDS, solid, highly toxic

Name of substance(s): GREEN BUG KILLER

* Powder or crystals with perceptible odour
* Readily soluble in water

NATURE OF HAZARD

* Highly toxic
* Severe poisoning perhaps fatal by contact with skin, inhalation or ingestion unless special medical treatment is applied immediately
* Combustible
* Decomposes in a fire giving off toxic fumes. Symptoms may develop after several hours

PROTECTIVE DEVICES

* Suitable respiratory protective device
* Goggles giving complete protection to eyes
* Chemical protection suit, boots and plastic or rubber gloves
* Medical advice for special treatment
* Eyewash bottle with clean water

EMERGENCY ACTION - Notify police and fire brigade immediately

* Stop the engine
* No naked lights. No smoking
* Mark roads and warn other road users
* Keep public away from danger area
* Keep upwind
* Put on protective equipment before entering danger area

SPILLAGE

* Sweep up spilled substance but avoid making dust. Remove to safe place. Do not flush road with water. Consult an expert
* If substance has entered a water course or sewer or contaminated soil or vegetation, advise police

FIRE

* Keep container(s) cool by spraying with water if exposed to fire
* Extinguish preferably with waterspray, foam or dry chemical
* Do not use water jet
* If possible prevent water running into sewers
* Do not attempt to smother the fire

FIRST AID

* Remove contaminated clothing immediately and wash affected skin with soap and water
* Induce vomiting if a person is suspected to have swallowed the substance, but only if he is conscious
* Apply artificial respiration only if patient is not breathing or under medical supervision
* If substance has got into the eyes, immediately wash out with plenty of water for several minutes
* Special treatment by a doctor is required as soon as possible in cases of exposure to the substance or its vapours
* Persons who have inhaled the fumes produced in a fire may not show immediate symptoms. They must lie down and keep quite still and should be taken to a doctor with this card. Patient should be kept under medical observation for at least 48 hours

Additional information

TELEPHONE : 01-234-5678

Call the NCEC at Harwell for further information

HI No.:66

UN No.:2783

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NCEC6

APPLIES ONLY DURING ROAD TRANSPORT

ENGLISH

Figure 8. Example of a customised group text CEFIC Tremcard

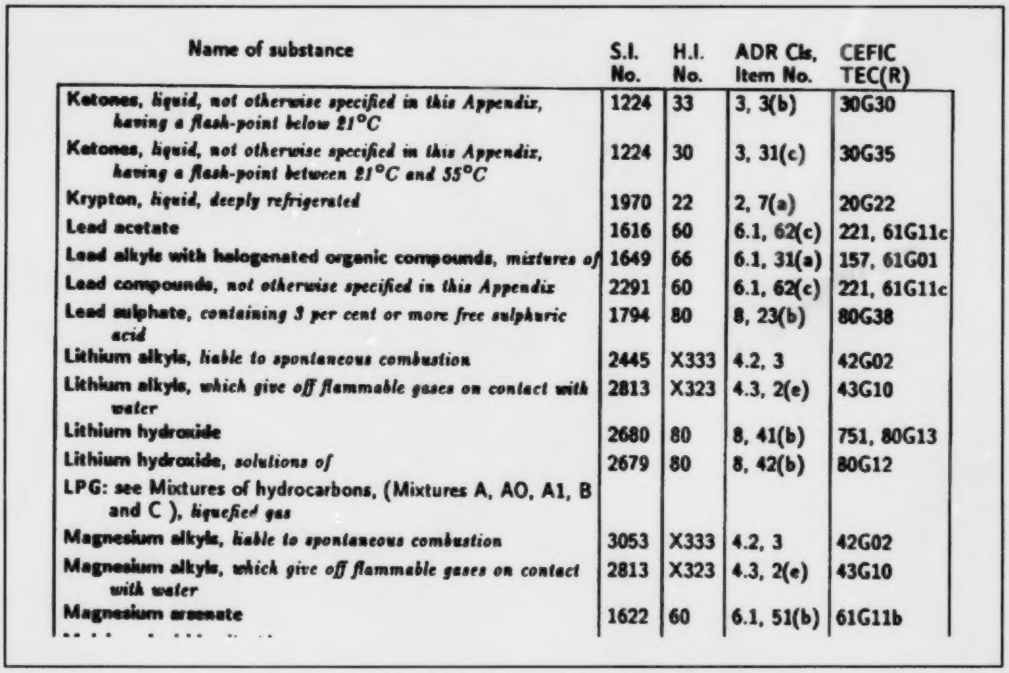
DESK-TOP PUBLISHING

The development of the Chemical Emergency Centre's vast source of information on chemicals, and the subsequent development of CHEMDATA and other computerised information systems, has enabled the Centre to answer a wide range of enquiries on many aspects of chemical safety, transport and legislation. The Centre has also had to keep up with the rapidly changing face of information technology, including computer hardware and software. As many of the general calls the Centre receives relate to the classification and labelling/placarding of chemical transport units, it was decided to bring together the commonly requested information and the Centre's computing experience, using the very latest desktop publishing techniques. Two publications have so far been produced, one aimed at the UK legislation and one at the European legislation. In collaboration with the UK Home Office, the first publication was the Home Office HAZCHEM list, indexing chemical names and UN numbers to the appropriate HAZCHEM code, providing the users of bulk transport units with the necessary information to placard/label their containers with the appropriate HAZCHEM code (the HAZCHEM Code being a two or three character code displayed on bulk transport units as a requirement of the UK Tanker Regulations. The code provides the emergency services with information on basic emergency response procedures, and is used in many countries world-wide.) Figure 9 shows a section of a typical page from the HAZCHEM List.

The second publication titled "CEFIC TREMCARDS and ADR APPENDIX B5" helps transporters of hazardous materials to identify appropriate Tremcards and placard labels, to satisfy the requirements of ADR and parts of domestic legislation. The book is indexed on chemical name, UN number, Tremcard number and ADR class and item number. Until now hauliers frequently had to seek advice from chemical authorities in selecting an appropriate Tremcard. The publication aims to make it far easier for a haulier to select his own Tremcard and placarding, ensuring that the correct information will be available to the emergency services in the event of an incident occurring. Figure 10 shows a section of a typical page from the publication.

S.I.N.	Substance	E.A.C.	A.P.P.	C.E.F.I.C. Tremcard No.	Hazards		A.D.R. H.I.N.
					Class	Sub Risks	
1571	**BARIUM AZIDE,** *wetted with not less than 50 per cent water by weight*	2 YE			4.1	6.1	
1572	**CACODYLIC ACID**	2 X			6.1		
1573	**CALCIUM ARSENATE**	2 X		61G11	6.1		60
1574	**CALCIUM ARSENATE AND ARSENITE, MIXTURES SOLID**	2 X			6.1		
1575	**CALCIUM CYANIDE**	4 X			6.1		
1576							
1577	**CHLORODINITROBENZENE**	2 W	AB	94A/ 94B/ 61G12/ 61G06	6.1		60

Figure 9. A section of a page from the 'HAZCHEM LIST No. 5'



Name of substance	S.I. No.	H.I. No.	ADR Cls, Item No.	CEFIC TEC(R)
Ketones, *liquid, not otherwise specified in this Appendix, having a flash-point below 21°C*	1224	33	3, 3(b)	30G30
Ketones, *liquid, not otherwise specified in this Appendix, having a flash-point between 21°C and 55°C*	1224	30	3, 31(c)	30G35
Krypton, *liquid, deeply refrigerated*	1970	22	2, 7(a)	20G22
Lead acetate	1616	60	6.1, 62(c)	221, 61G11c
Lead alkyls with halogenated organic compounds, *mixtures of*	1649	66	6.1, 31(a)	157, 61G01
Lead compounds, *not otherwise specified in this Appendix*	2291	60	6.1, 62(c)	221, 61G11c
Lead sulphate, *containing 3 per cent or more free sulphuric acid*	1794	80	8, 23(b)	80G38
Lithium alkyls, *liable to spontaneous combustion*	2445	X333	4.2, 3	42G02
Lithium alkyls, *which give off flammable gases on contact with water*	2813	X323	4.3, 2(e)	43G10
Lithium hydroxide	2680	80	8, 41(b)	751, 80G13
Lithium hydroxide, *solutions of*	2679	80	8, 42(b)	80G12
LPG: see Mixtures of hydrocarbons, (Mixtures A, AO, A1, B and C), *liquefied gas*				
Magnesium alkyls, *liable to spontaneous combustion*	3053	X333	4.2, 3	42G02
Magnesium alkyls, *which give off flammable gases on contact with water*	2813	X323	4.3, 2(e)	43G10
Magnesium arsenate	1622	60	6.1, 51(b)	61G11b

Figure 10. A section of a page from 'CEFIC TREMCARDS & ADR APPENDIX B5'

SUMMARY

The updating of CHEMDATA, both in content and ease of use, and its continuing increased distribution, together with clear, comprehensive reference sources of information and up to date Tremcards, help to provide the public emergency services with valuable sources of specialist information. Despite this a large number of emergency calls are still received by the Chemical Emergency Centre, proving the value of a central source of expertise available twenty-four hours a day.

REFERENCES

1) CHEMSAFE - a manual of the Chemical Industry Scheme for Assistance in Freight Emergencies, Chemical Industries Association, London, 1986

2) Cumberland, R F, "CHEMDATA: A microcomputerised chemical information system.",Fire Chief Magazine, Vol. 28, No. 1, Page 39, (1984)

3) Department of Transport, European Agreement concerning the International Carriage of Dangerous Goods by Road (ADR), Her Majesty's Stationery Office, London, 1988

4) TREMCARDS - An Introductory Brochure, CEFIC, Zürich, 1988

5) Home Office, HAZCHEM LIST No. 5, Home Office/National Chemical Emergency Centre, Harwell UK,1988

6) UK Statutory Instrument No. 1059, The Dangerous Substances (Conveyance by Road in Road Tankers and Tank Containers) Regulations 1981, Her Majesty's Stationery Office, London, 1981

7) CEFIC TREMCARDS and ADR Appendix B5, National Chemical Emergency Centre, Harwell UK, 1989

Etat de l'art sur les travaux effectués en France en matière de lutte contre les déversements chimiques

par Roger KANTIN et Marthe MELGUEN
CEDRE (Centre de Documentation de Recherches et
d'Expérimentations sur les pollutions accidentelles des eaux)

Séminaire sur les
Marchandises dangereuses - Mesures d'intervention d'urgence 1989

Halifax, 16-18 mai 1989

INTRODUCTION

L'augmentation du trafic des substances dangereuses en mer et dans les eaux intérieures en France, ainsi que la recrudescence des incidents ou accidents mettant en cause des produits chimiques, ont conduit les autorités françaises à poursuivre leurs efforts en matière d'intervention d'urgence, face au risque chimique.

C'est dans ce contexte que le CEDRE* (Centre de Documentation de Recherches et d'Expérimentations sur les pollutions accidentelles des eaux), a, depuis cinq ans, entrepris en collaboration avec ses partenaires (Marine Nationale, Ministère de l'Environnement, Mission Interministérielle de la Mer, Agences Financières de Bassin, Sécurité Civile) un vaste programme d'études, relatif à l'intervention et à la lutte contre les pollutions accidentelles des eaux marines et continentales par les substances dangereuses.

*Le CEDRE est une association placée sous la tutelle du Ministère de l'Environnement. Son Conseil d'Administration, formé de vingt et un membres, comprend :
- 7 représentants de l'Etat,
- 7 représentants des syndicats professionnels ou des organismes de recherches,
- 7 personnalités (élus) représentant les départements littoraux,

notamment.

Quelques données sur le CEDRE :
- 9 millions de francs de budget annuel,
- 25 personnes,
- un centre de documentation spécialisé,
- un terrain d'expérimentation.

Ses missions : Information, Formation, Recherche et Expérimentation, Assistances aux Autorités Françaises chargées de la lutte antipollution.

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Parmi les thèmes d'action qui ont été entrepris, on peut citer :

. L'étude du risque lié au trafic - Les accidents

- recensement des données concernant le trafic des produits chimiques (transit, chargement, déchargement) et les accidents ou incidents de mer,
- établissement d'une "liste prioritaire" de 200 produits chimiques (vrac et colis),
- étude d'évaluation des risques de pollution par substances dangereuses autres que les hydrocarbures, en Méditerranée.

. La connaissance du risque chimique

- recensement et choix de banques de données complémentaires et représentatives de différents domaines, comme la connaissance des propriétés et des risques, les tactiques d'intervention et les méthodes de lutte,
- adaptation, aux besoins nationaux, de modèles prévisionnels d'évaluation des risques et de systèmes d'aide à la décision,
- établissement d'un système de classification des produits chimiques, basé sur leur comportement en cas de déversement accidentel en mer et les méthodes de lutte à mettre en oeuvre.

. Les méthodes et moyens d'intervention

- étude des techniques d'approche d'un chimiquier en avarie,
- choix des appareils portables à utiliser en priorité pour identifier et mesurer des vapeurs toxiques en mer,
- mise au point d'un scaphandre de protection autonome en butyl/nomex/viton et étude des contraintes physiologiques liées au port de l'équipement.

. La lutte contre les déversements

- adaptation des moyens de lutte utilisés pour les hydrocarbures à la récupération de certains produits chimiques flottants : compatibilité entre les matériaux constitutifs de barrages, récupérateurs, réservoirs et pompes, traitement des produits chimiques flottants (essais de dispersion, absorption, gélification),
- récupération des colis toxiques, flottant en mer et échoués sur le littoral.

I - TRAFIC/ACCIDENTS DE NAVIRES TRANSPORTANT DES PRODUITS CHIMIQUES

I.1. L'étude de statistiques de transport

Environ 30 millions de tonnes de produits chimiques autres que les hydrocarbures transitent chaque année en Manche. Plus de cinq millions de tonnes de produits chimiques sont chargés et déchargés, chaque année, à Marseille, premier port méditerranéen. Une étude précise des produits transportés en vrac, en Manche, a été effectuée ainsi qu'une étude portant à la fois sur les produits transportés en vrac et en colis en Méditerranée.

Ces données ont conduit à dresser une liste de 200 produits les plus transportés (par voie maritime) le long des côtes de France (cf. annexe I).

I.2. L'étude des accidents et incidents de mer survenus le long des côtes françaises

L'accident le plus grave a eu lieu en 1947, dans le port de Brest, où l'"OCEAN LIBERTY" explosait, faisant 21 victimes. Ce cargo transportait du nitrate d'ammonium (tout comme le "GRANDCAMP" qui explosa trois mois auparavant dans le port du Texas City).

Depuis, aucun accident grave ne s'est produit dans les eaux territoriales françaises. D'autres accidents (hors pétroliers) se sont produits dans les eaux côtières espagnoles, italiennes, belges, hollandaises ou internationales, épargnant les eaux côtières françaises jusqu'à présent.

Cependant, les conditions météorologiques, en particulier au large de la Bretagne, sont connues pour être, notamment en hiver, très rudes. C'est ainsi qu'au début février 1988, un "coup de tabac" déchira deux soutes et arracha neuf couvercles de citernes du pétrolier de 32 000 tonnes "AMAZZONE", témoignant de la violence des conditions météorologiques régnant à cette époque de l'année.

Au même moment, le cargo "BREA" perdait 700 fûts de produits chimiques transportés en pontée, dans des conteneurs ; la cargaison coula au large de la Bretagne, alors que le vent soufflait à plus de 100 km/h et que la houle atteignait des creux de 6 mètres. La cargaison était composée de matières solides (soude, métaldéhyde), de liquides inflammables (acétone, isopropanol, n-propylacétate, butylacrylate, orthoformiate d'éthyle), de matières toxiques (pesticides organophosphorés, diphényl méthane-diisocyanate, p-aminophénol sulfate, hydroquinone) et de matières corrosives (sulfure de sodium, acides chlorhydrique, propionique et formique).

Une trentaine de cas de perte de fûts ont été enregistrés au CEDRE ces dix dernières années, mettant en cause une centaine de produits chimiques différents, dont certains particulièrement dangereux (aniline, cyanure de sodium, phénol, plomb tétra-éthyle).

I.3. Liste prioritaire de produits chimiques

Sur la base de données de trafic et d'accidents, une liste de produits chimiques "à étudier en priorité" a été établie : ce sont les produits qui ont la probabilité de déversement la plus importante (sur la base du tonnage et/ou du nombre de voyages effectués) ; c'est parmi ces produits que notre effort s'est porté en terme de "prévention des risques" : nous avons, pour ce faire, sélectionné une soixantaine de produits chimiques présentant différents profils de risques et ayant des comportements différents en cas de déversement accidentel (cf. annexe II). Pour chacun de ces produits, le CEDRE rédige actuellement un guide d'intervention à caractère opérationnel (incluant des scénarios d'accident).

I.4. Evaluation des risques de pollution en Méditerranée

Une étude réalisée par le CEDRE pour le compte de l'OMI a permis de mieux cerner le risque d'accident pouvant entraîner une pollution accidentelle par produits chimiques en Méditerranée.

Chaque jour, transitent en Méditerranée environ 600 navires de plus de 100 tjb, soit le tiers du trafic pétrolier mondial et le sixième du commerce maritime international. Le risque d'accident a été estimé à 0,03% (toutes marchandises confondues), soit environ 10 accidents par an, pouvant affecter les navires transportant des cargaisons dangereuses. Ce sont les navires transportant des produits en colis (environ 40% en nombre de voyages mais 2,5% en tonnage), avec des cargaisons unitaires inférieures à 100 tonnes, qui présentent le risque d'accident le plus élevé.

II - LA CONNAISSANCE DES RISQUES LIES AUX PRODUITS

II.1. Inventaire des sources d'information

Un inventaire des sources d'information, informatisées ou non, a été effectué aux niveaux national et international.

La collecte et le traitement rapide de l'information sont en effet des éléments clés pour orienter la prise de décision. Devant la multiplicité de la documentation disponible de par le monde pour connaître les dangers d'un produit et les mesures à prendre, il était bon d'avoir une procédure de collecte de l'information qui ait fait ses preuves ; celle proposée par le CEDRE est la suivante :

a) Tout d'abord, consulter les ouvrages qui fournissent les données de base : CHRIS, GESAMP, Code IMDG de l'OMI, "Manual for spills of hazardous materials" d'Environment Canada, fiches toxicologiques de l'INRS.

b) Consulter les guides de première urgence : ceux de l'OMI, de l'U.S. Department of Transportation, du CANUTEC, des Sapeurs-Pompiers Genevois, Urgences toxicologiques,...

c) Recueillir des informations plus détaillées en consultant la série canadienne des ENVIROGUIDES, la banque HSDB (Hazardous Substances Data Bank), la banque IRPTC (International Register on Potentially Toxic Chemicals), les ouvrages de la série Environmental Health criteria de l'OMS ou ceux du NTIS (dans la série "Criteria for a recommended standard").

d) Obtenir des compléments d'information sur des points précis:
. lutte anti-incendie (guide du NFPA, de la Société Alpine de Publications),
. réactivité (Bretherick, INRS, ...),
. s'il y a des pesticides, consulter notamment le "Pesticide Manual" ou l'"Agrochemical Handbook".

e) Si les informations ci-dessus sont incomplètes, rechercher l'information auprès des différents centres d'information (comme ceux cités dans le Système Communautaire d'Information (Europe), le CANUTEC et le CHEMTREC.

f) Des informations ponctuelles mais peu approfondies peuvent être trouvées dans encyclopédies ou dictionnaires (Dangerous Properties of Industrial Materials, Condensed Chemical Dictionary, Merck Index, ...).

II.2. Les modèles prévisionnels

Le CEDRE utilise actuellement le H.A.C.S. (Hazard Assessment Computer System) pour les déversements en eaux côtières ; le système a été traduit en français et mis à disposition de la Marine Nationale.

Plusieurs modèles existent en France pour les eaux intérieures, mis au point par les Sociétés des Eaux ou les Agences de Bassin ; le CEDRE dispose aussi du rSpill.

Un important effort est effectué pour implanter en France le système d'aide à la décision SEABEL, élaboré par le TNO (Hollande) dans le cadre d'un co-financement de la Communauté Economique Européenne (CEE). Ce système contient un modèle de dérive de nappes et un modèle de dispersion atmosphérique, ainsi qu'un recueil des méthodes d'intervention et de lutte à mettre en oeuvre dans chaque cas. Cet outil est destiné à aider l'opérationnel dans le choix des méthodes de lutte, en lui donnant des informations qui concernent à la fois les propriétés des produits, les risques que font courir ces substances et les mesures d'urgence à mettre en oeuvre.

Notons qu'en France, trois banques de données sont accessibles par MINITEL :

- SECURICI, banque de données mise au point par la Direction de la Sécurité Civile (Risques et Mesures d'urgence),
- FDE, qui contient, entre autres, des informations sur les méthodes de prélèvement et d'analyse,
- SECURLINE (lutte anti-incendie notamment).

Un grand nombre de banques de données existent aussi à l'étranger: OHM-TADS, RTECS, CIS, EXIS, CIRUS, CHEMDATA, CHEMSTOR, HAZFILE, DABAWAS, RISK, BIG, BVINFOTANK, ECDIN, ...

En ce qui concerne la mise à jour des matériels et produits de lutte des différents stocks français, le CEDRE a mis au point une base de données appelée SIMPA (Système d'Information sur les Moyens de lutte Antipollution).

II.3. La classification des produits chimiques accidentellement déversés

En collaboration avec le Rijkswaterstaat hollandais et la Garde Côtière suédoise, le CEDRE a contribué à finaliser le "système européen normalisé de classification des produits chimiques déversés accidentellement en mer", présenté à l'annexe III.

Ce système répartit les produits chimiques suivant l'état de la matière et leur comportement en cas de déversement dans l'eau (réactivité, densité, pression de vapeur, solubilité). Cette classification a été effectuée dans le but d'aider l'opérationnel à mettre en oeuvre les méthodes de lutte en cas de déversement accidentel.

III - LES METHODES ET MOYENS D'INTERVENTION

III.1. Appareils de mesure

Une évaluation des différents équipements portables disponibles sur le marché pour mesurer ou identifier des gaz ou des vapeurs dans l'air et des substances dans l'eau, a été effectuée. Une série de tests ont permis de vérifier les performances et les limites de certains de ces appareils et de recommander l'acquisition de certains d'entre eux par la Marine Nationale.

L'étude a été poursuivie par des essais sur des tubes à prélèvement, munis de différents supports et couplés avec différents types de pompes.

III.2. Scaphandre de protection

En collaboration avec la CEPPOL (Commission d'Etudes Pratiques de lutte Antipollution - Marine Nationale) et la Société MATISEC, le CEDRE a mis au point un vêtement de protection pour intervenir sur un navire en avarie, transportant des substances dangereuses. Le vêtement est en NOMEX (150g/m2), enduit de viton A (300g/m2) à l'extérieur et de Butyl (200g/m2) à l'intérieur. Ce vêtement, à la fois flexible et résistant, est recouvert d'une visière en polycarbonate recouvert de teflon. La fermeture éclair, les gants et les bottes sont aussi recouverts de viton. Le système respiratoire retenu pour l'instant, est un système à KO2 (circuit fermé), qui peut être utilisé, sans danger pour le porteur, pendant une heure environ.

Les contraintes physiologiques liées au port de l'équipement ont été étudiées sur des périodes de deux heures et ont conduit à de nouvelles études destinées à diminuer ces contraintes (contraintes liées au poids du système et à la chaleur notamment). Un système de communication avec l'extérieur et un appareil de contrôle de la fréquence cardiaque font également partie du scaphandre.

III.3. Approche d'un navire en avarie

En tenant compte de ces acquis, ainsi que des principales recommandations opérationnelles d'usage, les différents aspects liés à l'approche d'un navire en avarie ont été étudiés et consignés dans un ouvrage.

IV - LA LUTTE CONTRE LES DEVERSEMENTS

IV.1. Allègement

En cas d'urgence, le chargement pour être transféré :
- de citerne à citerne,
- de conteneur à conteneur,
- de navire à navire.

Des tests portant sur la compatibilité de plusieurs produits chimiques vis à vis des matériaux constitutifs de pompes et tuyaux ont été effectués en laboratoire. Cette étude a notamment permis de recommander les pompes FRAMO TK5 et TK8 associées avec des tuyaux en acier inoxydable, lors des opérations d'allègement d'une cargaison chimique.

IV.2. Confinement/Récupération

Les matériaux constitutifs des barrages BALEAR (323, 333), POLLUGUARD (130 MANCHE) et VIKOMA (SEABOOM), des récupérateurs SIRENE 20, ESCA de haute mer, DESTROIL, CYCLONET et NETPOL, et des pompes SYKES, GUINARD, MOUVEX, STORK, DOP 10 et WILDEN 48 ont été testés vis à vis d'une vingtaine de produits chimiques différents.

Nous avons noté, parmi nos conclusions, que :

- l'acier inoxydable (AISI 316 L) est corrodé à certaines températures et dilutions, par la soude et l'acide phosphorique,
- les tuyaux en néoprène posent des problèmes en cas de contact avec la plupart des solvants aromatiques,
- les matériaux composés d'alliage d'aluminium sont corrodés par la soude et certains acides,
- l'hypalon utilisé dans les barrages est sérieusement endommagé par la plupart des produits,
- les revêtements en polyamide sont endommagés par les acides.

IV.3. Dispersants

L'efficacité du dispersant de troisième génération FINASOL OSR 5 a été testé en laboratoire sur une vingtaine de produits chimiques (à l'aide du test dynamique en dilution) et en milieu naturel contrôlé, dans des cellules flottantes, sur l'éthyl-2 hexanol.

En dehors des critères liés à la toxicité du mélange produit chimique/dispersant, l'utilisation de dispersants pétroliers pour traiter les pollutions chimiques semble envisageable pour l'acrylate de n-butyle, le dodécylbenzène, l'éthyl-benzène, l'éthyl-2-hexanol, le styrène et le xylène. La nature auto-dispersante de quelques produits a aussi été mise en évidence : l'acétate de n-buyle, l'aniline, le n-butanol et la méthy-isobutyl-cétone ont, dans les conditions du test, une dispersibilité supérieure à 50%.

IV.4. Absorbants

Des tests ont été effectués en laboratoire, sur deux absorbants en vrac : le BULTHANE (polyuréthane) et le 3M (polypropylène). Les études ont été complétées, en milieu marin, sur ces deux produits ainsi que sur le FIBERPERL (perlite et cellulose), l'OCLANSORB (fibres de tourbes) et l'ISOVER (laine de verre).

Les doses absorbant/produit chimique recommandées sont de l'ordre de 1/10 (en poids), avec cependant des variations selon les produits. Parmi les facteurs qui influent sur la cohésion de l'agglomérat (évitant le relargage du produit une fois récupéré), citons, outre la viscosité, la polarité du produit. Parmi les couples absorbant/produit chimique ayant donné les meilleurs résultats, citons : Fiberperl/Xylène (1/5), 3M/Xylène (1/12), Bulthane/Acétate de butyle (1/12), Fiberperl/Acétate de butyle (1/5) et Fiberperl/Ethyl-2 hexanol (1/5).

IV.5. Gélifiants/plastifiants

Les produits de traitement connus sous le nom de RIGIDOIL, ELASTOL et NORSOREX ont été testés sur une vingtaine de produits chimiques, purs ou déversés dans de l'eau de mer.

Les alcools (butanol, éthyl-2-hexanol, éthylène glycol, hexanol, méthanol, orthocrésol) ne sont pas gélifiés, du moins pour des rapports gélifiant/produit chimique recommandés pour le pétrole ; pour ces produits polaires, des rapports de 1/1 au moins sont nécessaires pour obtenir une prise en masse du produit pur.

Par ailleurs, d'autres produits chimiques comme le benzène, le chloroforme, le cyclohexane, le tétrachlorure de carbone, le trichloréthylène et le xylène peuvent être traités pour des rapports produit de traitement/produit chimique, de l'ordre de ceux qui sont recommandés pour les hydrocarbures (essais sur le produit pur et le produit épandu dans l'eau de mer). Pour ces produits, le RIGIDOIL et le NORSOREX semblent les plus efficaces et le coût du traitement est compatible avec celui du pétrole.

IV.6. Récupération de fûts toxiques

Le CEDRE a conçu et mis au point un dispositif de suremballage des fûts endommagés ou non pour en permettre la manipulation et le transport en toute sécurité. Une procédure de manutention (avec releveur de fûts et chariot de manutention tout terrain) a été mise au point pour la récupération à la côte, dans les zones d'accès difficiles (rochers) et une autre procédure pour la récupération de fûts flottants en mer (filet de récupération actionné par une grue, avec introduction directe dans le fût d'intervention).

CONCLUSION

Dans son plan à moyen terme 89-92, le CEDRE, en collaboration avec ses partenaires, envisage de continuer à étendre ses travaux dans ce domaine, en optimisant l'utilisation des systèmes d'aide à la décision (augmentant leur rapidité d'utilisation et leurs performances), en rédigeant de nouveaux guides opérationnels et en étudiant, par des déversements expérimentaux à grande échelle, le comportement des produits déversés et les méthodes de lutte à mettre en oeuvre.

Ces actions sont aussi valorisées aux niveaux national et européen, par le biais de stages de formation (INFOPOL, Sécurité Civile, MEDIPOL, RISC, CEDRE-CEE), ainsi que par le truchement d'expertises réalisées pour le compte d'organisations internationales (OMI, PNUE) et dans le cadre de la "task force" de la CEE.

ANNEXE I

LISTE DES 200 PRODUITS LES PLUS TRANSPORTES
(au large des côtes françaises)

1.- Gaz liguéfiés et liquides volatils (température d'ébullition < à 40°C) transportables en vrac

1 Acétaldéhyde
Ammoniac
Anhydride sulfureux
Bromure de méthyle
Butadiène
Butane
Butylène
Chlore
Chlorure de méthyle
10 Chlorure de vinyle
Ethane
Ether éthylique
Ethylène
Isobutylène
Isoprène
Isopropylamine
Méthane
Oxyde d'éthylène
Oxyde de propylène
20 Propane
21 Propylène

2.- Autres substances transportables en vrac

1 Acétate de butyle
Acétate de vinyle
Acétone
Acide acétique
Acide chlorhydrique
Acide formique
Acide heptanoïque
Acide nitrique
Acide phosphorique
10 Acide propionique
Acide sulfurique
Acrylamide
Acrylate de butyle
Acrylate d'éthyle
Acrylonitrile
Alcool furfurylique
Alcool isopropylique
Alcool tertiobutylique
Alkylamines + polyamines
20 Alkylbenzène
Ammoniac
Anhydride maléique
Benzène
Borax
Butylène glycol
Carbonate de calcium
Carbonate d'éthyle
Carbonate de sodium
Chlorate de sodium

30 Chloroforme
Chlorure ferrique
Créosotes
Crésol
Cyclohexane
Cyclohexène
Cyclononène
Diacétone alcool
Dibromure d'éthylène
Dichlorobenzène
40 Dichloroéthane
Dichloréthylène
Dichromate de soude
Diisobutylène
Diisocyanate de diphényl - méthane
Diisocyanate de toluène
Diméthyl formamide
Dinitrotoluène (solution)
Dipentène
Dipropylène glycol
50 Dodécyl benzène
Engrais
Ethanolamine
Ethyl benzène
Ethylène glycol
Ethyl - 2 hexanol
Ferrosilicium
Glycol
Hexane
Hexanol
60 Huile de poisson
Huile végétale
Hydroxyde de potassium
Hydroxyde de sodium
Hypochlorite de calcium
Latex
Mélasse
Méthacrylate de butyle
Méthacrylate de méthyle
Méthanol
70 Méthyl isobutyl cétone
Morpholine
Nitrate d'ammonium
Nitrite de sodium
Nonène
Octène
Paraffines
Perchloréthylène
Peroxyde d'hydrogène
Phénol
80 Phosphate d'ammonium
Phosphate de calcium
Phosphore
Plomb tétraéthyle
Propylène glycol
Soufre (liquide)
Styrène
Sulfate d'ammonium
Sulfure de sodium
Toluène

90 Trichloréthylène
Trichlorobenzène (liquide)
Trichloroéthane
Triéthylamine
Uranium métal, pyrophorique
Urée
96 Xylènes

3. Substances transportées exclusivement en colis

1 Acétylène
Acide thioglycolique
Acide trichloroisocyanurique
Aldrin
Aluminium
Anhydride arsénieux
Anhydride chromique
Anhydride phosphorique
10 Argon
Arsenic
Azote
Bifluorure d'ammonium (solution)
Bisulfate de sodium
Bromate de sodium
Butanediol
Calcium
Carbonate de méthyle
Carbure de calcium
20 Chloral
Chlorate de potassium
Chlorite de sodium
Chloroaniline (liquide)
Chlorodifluorométhane (+Chloropentafluoroéthane)
Chloroformiate d'éthyle
Chloroformiate d'éthyl-2 hexyle
Chloroformiate de méthyle
Chloronitroaniline
Chloropicrine + bromure de méthyle
30 Chlorure d'aluminium
Chlorure de thionyle
Chlorure de triméthylacétyle
Cyanure de potassium
Cyanure de sodium
Cyclooctadiène
DDT
Diamine (hydrazine)
Diamino -4,4 diphényl méthane
p - Dichlorobenzène
40 Dichlorodifluorométhane
Diméthoate
Dioxyde de carbone
Disulfure de diméthyle
Endosulfan
Ethyl mercaptan
Ethyl méthyl cétone
Ethyl parathion
Formiate d'éthyle
Formol

50 Furfural
Hexafluorure de soufre
Hexaméthylène tétramine
Hydroquinone
Hydrosulfite de sodium
Hypochlorite de sodium
Isocyanates
Isothiocyanate de méthyle
Lindane
Manèbe
60 Mercaptan
Méthyl bromacétone
Méthyl parathion
Naphtalène (solide)
Nitrate de potassium
Nitrate de sodium
Nitrocellulose
Oxygène liquide
Pentachlorophénate de sodium
Pentoxyde de vanadium
70 Percarbonate de sodium
Peroxyde de benzoyle
Phosphate de sodium
Polystyrène
Protoxyde d'azote
Siliciure de calcium
Silicocalcium (et Silicomanganocalcium)
Sodium
Sulfate de diméthyle
Sulfure de carbone
80 Térébenthine (succédané)
Tétranitrate de pentaérythrite
Trinitrotoluène
83 Xylidines

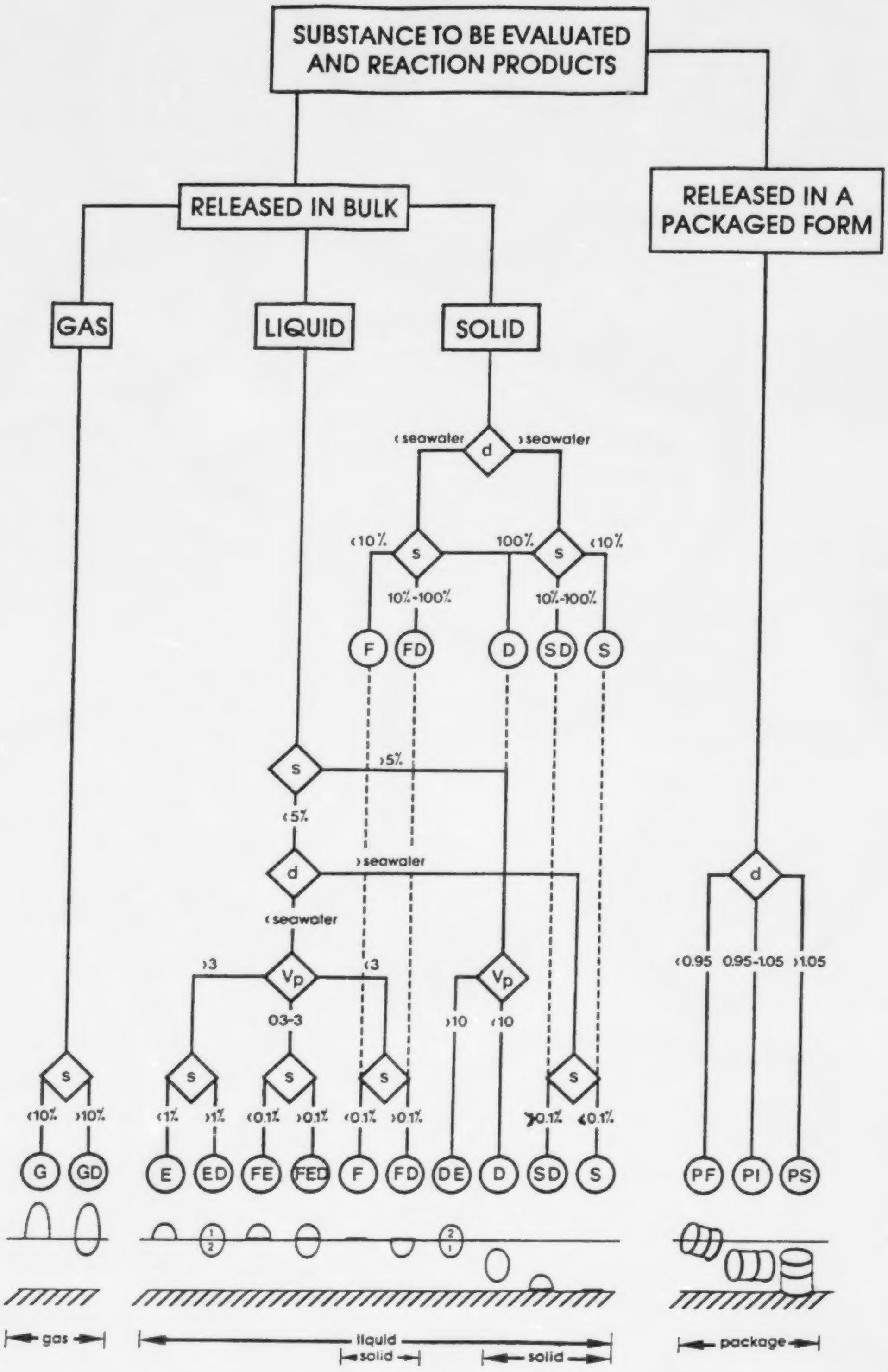
Annexe II

"LISTE PRIORITAIRE" DE PRODUITS CHIMIQUES (les plus transportés et/ou les plus dangereux) Objet de la préparation de guides d'intervention

Acétate d'éthyl glycol
Acétone cyanhydrine
Acide chlorosulfurique
Acide Formique
Acide phosphorique
Acrylonitrile
Aldrin
Ammoniac
Aniline
Anhydride arsénieux
Benzène
Butane
Byphényls polychlorés
Caisure de calcium
Chlorate de calcium
Chlore
Chloroformiate d'éthyle
Chlorure de vinyle
Composés du Baryum
Créosotes
Cyanure de sodium
Cyclohexane
Dichlorodifluorométhane
Dibutylphtalate
Diisocyanate de toluène
Dodécylbenzène
Explosifs de mine de type A
Ferrosilicium
Formol
Hexaméthylène tétramine
Hexanol
Huile de suif
Isoprène

Manebe
Mercure
Méthane
Méthanol
Méthyl mercaptan
Méthyl parathion
Méthyl-isobutyl-cétone
Méthyl méthacrylate
Naphta
Naphtalène
Nitrate d'ammonium
Nitrocellulose
Oxyde Propylène
Peinture
Perchloréthylène
Peroxyde d'éthyl-méthyl-cétone
Peroxyde d'hydrogène
Phénol
Phosgène
Plomb tétra éthyle
Sodium
Soude
Soufre
Styrène
Sulfure de carbone
Triméthyl-chlorosilane
Urée
Xylènes

ANNEXE III


SUBSTANCE TO BE EVALUATED AND REACTION PRODUCTS
RELEASED IN BULK
RELEASED IN A PACKAGED FORM
GAS
LIQUID
SOLID
d
‹seawater
›seawater
s
‹10%
10%-100%
100%
s
10%-100%
‹10%
F
FD
D
SD
S
s
›5%
‹5%
d
›seawater
‹seawater
Vp
›3
‹3
03-3
Vp
›10
‹10
d
‹0.95
0.95-1.05
›1.05
s
‹10%
›10%
s
‹1%
›1%
s
‹0.1%
›0.1%
s
‹0.1%
›0.1%
s
›0.1%
‹0.1%
G
GD
E
ED
FE
FED
F
FD
DE
D
SD
S
PF
PI
PS
1
2
2
1
gas
liquid
solid
solid
package

Air and water temperature : 10 or 20°C
Atmosphere pressure : 100 kPa
s : solubility (%)
d : density (seawater)
Vp : vapeur pressure (kPa)

G : gas
E : evaporator
F : floater
D : dissolver
S : sinker
P : package
I : intermediate

DIFFICULTIES IN AROUSING PUBLIC AWARENESS TO CHEMICAL EMERGENCIES AND THE INSTITUTION OF CHEMICAL SAFETY PROGRAMS

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AUTHOR'S NOTE

I am a canadian federal public servant, I am, and have for the past 18 months, been on loan to the Centro Panamericano de Ecologia Humana y Salud, which is one of seven regional Centers of the Panamerican Health Organization, the Americas' arm of the World Health Organization. My assignment is to help develop a regional chemical safety program for the Region of the Americas. This includes the development of chemical safety materials in the languages of the Region, and the encouragement of the development of national chemical safety programs by the countries themselves.

The descriptions, perspectives, comments and conclusions of this paper are entirely personal, and do not reflect the views of the Organization to which I am attached. They are based upon direct observation of events and activities in a number of the countries of the Region, and upon conversations I have had with many persons, some professional, others not, in government institutions and agencies and in industry. They tend to be bleak, and by nature are generalized. Exceptions to the general descriptions are to be found from the actions of the dedicated and persevering persons who are encountered in the Region and who, perhaps despite the general conditions, succeed in making achieving progress in the promotion of chemical safety by their individual efforts.

INTRODUCTION

Latin America is a vast geographical area, it includes 20 countries, has a total estimated population to the order of 280 millions and runs south and north of the equator from Argentina and Chile to Mexico. The names of the countries range from the A's (Argentina) to the V's (Venezuela). It is a diverse area, enjoying (or suffering) from all types of terrain, and geological and climatic conditions, whose people are widely differing: ranging from the still stone-age indians of the Amazonian jungles, through the incredibly historically interesting indians of the Aztecas, Incas, and Mayas (with all of their sub-groups and cultures) to the relatively recent European, Asian and African arrivals.

Throughout this vast web of peoples, climates, geology, and terrain there are a number of unifying features:

1. language - the majority speak spanish, although Brazil with its portuguese heritage represents a major separate language block which nevertheless does communicate with its spanish cousins through the fascinating language of "portugnol" - a

linguistic phenomenon similar to Canada's own "franglais",

2. legal systems - which due to the languages and religious origins of the Region are largely based on the principles of Roman Law,
3. governments - all of them are Republican, most of them are within the "democratic" arena, albeit somewhat recently, and struggling to stay there,
4. economies - can be described as "mixed" for the most part, with private and publicly owned companies sharing the responsibilities for manufacturing, distribution and transportation, and the service industries.

A number of common but not unifying features of the region are unstable and perhaps deteriorating economic situations with high inflation - ranging from 40% to 400% or more; major international debts; high unemployment levels - ranging from 20% to 40%; and in many areas high underemployment and subsistence levels of living.

Latin America is also a region of stark contrasts: with the highly educated sharing cities with the illiterate; with mansions next to hovels; with systems of transportation vying with the most modern in the world yet operating side by side with the ox or mule cart and 1989 model vehicles sharing the road with 1949 models. Banking systems can be as advanced as our own in terms of electronic systems and automatic tellers, but many in the populations do not use banks at all; and so the contrasts go on and on, through every field of activity - hospitals, schools, agriculture, mining, forestry and the manufacturing industries.

THE CURRENT SITUATION

The Chemical Industry

The latin american chemical industry is like Canada's - mostly multinational corporations - you would recognize the same basic 10 to 15 corporate names, despite the language differences - producing a generally limited range of products in relatively large quantities, and relying on imports from the United States or Europe (or increasingly Japan and the Pacific Rim countries) for the specialty chemicals used directly in smaller quantities or for blending and re-packaging before distribution and use within the region.

Visits to the plants of these corporations leaves you with intense feelings of familiarity to Canada's plants - the hardware of the plants, the plant layouts, the retorts and storage facilities are all the same as our own. There are the safety statistic notices at the plant entrances, the occupational health and safety warnings and signs that we would see here. The obvious differences: the tropical trees and flowers, and the buildings - particularly the windows, doorways and the roofs - reflecting of course, the climates. But there are subtle differences in the operation of the plants that reflect the society in which the plants operate.

Regulations - transport of dangerous goods With the exception of Argentina and Brazil, there are fundamentally no "transport of dangerous goods regulations" at least for the land modes of transport, and even in those countries, those regulations are both embryonic and largely neither enforced nor complied with. Marine and air transport regulations based on IMO and ICAO do exist more generally, but as rule conformity with them is low except with regard to traffic originating outside the Region. As a consequence, while the drums and packagings used may very often bear "DOT" construction standard markings (a legacy of the multinational corporation habits), there is no follow through - neither an inspection nor a testing system in place to assure the quality of the production. Tank vehicles' cargo tanks often look like Canada's in terms of design and shape, but I have yet to see a manufacturer's certification plate or the periodic inspection certifications on the side of a tank truck's cargo tank with a few notable exceptions - the compressed gas products industry, for example - many of them don't look well maintained at all. Inspection of a tank vehicle before loading is almost totally concerned with its previous contents - the interest lies in ensuring that there is no contamination of the product about to be loaded: the cargo tank's or the vehicle's mechanical safety condition are not particularly checked, and I have observed vehicles leaving the plants for a journey of more than 500 km in temperatures higher than 38 degrees celsius with tires that have shed portions of the tread and with deep gouges and splits in the side walls, and with leaking discharge valves.

Regulation - transport labelling and occupational safety information Even within the large chemical plants, there does not seem to be a tendency to pursue information dissemination and the related training, and only in a few of the plants that I have visited, have I seen any serious effort made to use any type of internationally recognized labelling on packagings that are being shipped from the plant whether for domestic or for export destinations. Nor does there seem to be a policy to have the Material Data Safety Sheets available in spanish or portuguese for the benefit of the plant workers. Certainly, most of the senior engineering and safety personnel have some knowledge of English or another language (especially in the case of US or European subsidiaries) and do have MSDS's from the USA - but these are in English, or in the case of Europe, French or German and only occasionally translated in spanish. The MSDS's are therefore naturally, not provided to customers or transport personnel.

Regulation - environmental protection Few of the countries have tackled the question of establishing norms for the emission of pollutants either into the air or to the land or water systems. In some of these countries, success is being found in remedial programs to lower plant emissions, but this is the exception rather than the rule. Where multinational plants install the systems, it is normally only in the most modern plants, and retro-fitting older plants faces and even greater problem than in Canada. Air and water pollution in the areas around the chemical plants in Latin America is generally a serious problem, and often the solution is to locate new plants in isolated areas rather than to insist on the installation of suitable protective equipment.

General legislative issues None of the countries in the region, even those with regulatory programs, have tackled the issue of legislating financial liability for chemical spills or allocating responsibilities for emergency planning and response. This lack of legislation, perhaps more than anything else is encouraging the less than conscientious plants to ignore the industrial practices that are followed in the developed countries, and coupled with a tendency to avoid employer and management responsibilities through the practice of sub-contracting key activities, even within the plant, enables chemical safety practices and policies to be avoided.

Smaller scale activities The situation in the smaller scale "chemical" plants, of either users or producers, is even more disturbing - at this level of economic activity there is no multinational base of information, policies or procedures to transfer from, and such things, to the extent they exist are ad hoc and "home" grown and limited to the individual plant. Neither do such companies have any affiliation with national associations: whether commercial, industrial or safety oriented which might be a source of encouragement towards the implementation of safety practices.

The Transport Industry

Conversations with drivers, train crews and marshalling yard personnel, and port workers - as well as their respective managers, are all equally discouraging. In many countries the literacy rate for the workers in these industries is low to very low, and most of the work force (98%) have not received training or advice as to the nature of the products they are transporting or handling, do not understand the UN labels that appear on imported products, and in the case of those in control of tank vehicles, do not have any personal protective clothing or equipment at all. Exceptions of course do exist particularly where the personnel are handling single products - compressed gas products and gasoline are classic examples, and reflect the fact that this transportation is private transportation.

The most discouraging feature of this is that the managers in these commercial (for hire) modes of transport may well know of the international transportation of dangerous goods regulations, but somehow do not transfer that knowledge into operating practices and conditions. The IMDG Code for example is available in spanish, but is not widely know to exist in Latin America - even in that language, and often what I have come across is the odd outdated reference copy in English, the use of which is limited only to the management staff that have an understanding of that language. One factor in the lack of reference to these documents is the cost of them. Books that cost a $100 represent a major investment in Latin America, and this plus mail and customs problems also tend to limit interest in obtaining them.

The quality of the transport equipment has already been mentioned, and the same condition tends to apply to the handling equipment as well as to the storage facilities in which chemicals may be held.

The governments

In all of the countries, there do exist Ministries of Health, Transport, Civil Defense, Industry, Labour, Agriculture, etc, although not often in the organizational form that we might be familiar with. These governmental agencies are much more politicized than is the canadian case, more like the USA where even moderately senior officials can expect to lose their positions when the government changes, except that this changeover of staff tends to go deeper into the bureaucracy than even the USA. As a result, the possibility of developing a strong cadre of professional and continuing officials is lessened and the officials are much more sensitive to the political goals or concerns of the governments. There is also the situation that the players in the political side of the governments are often the same persons or families as the owners of industry. The Canadian interest in separation of Government from Industry (i.e. the avoidance of conflict of interest) is not yet a concern in Latin America - in fact the reverse is the case - the mutual interests of government and industry are dominant.

The government officials with whom I have had contact are for the most part very well qualified professionally, fully concerned with what is happening to their national environments, to worker and public safety, but lack the means to influence the decisions of government in these respects. Not only is there a lack of communication upwards through the bureaucracy, there is rarely horizontal communication between agencies which might have a mutual interest and influence. I have found examples of officials within different sectors of one Ministry who not only did not communicate with each other, had never apparently thought of doing so. As a result Labour does not talk to Transport, who don't talk to Civil Defense, who don't talk to Agriculture about even pesticides, their production, use, transportation and accidents - even though pesticides are probably the most well regulated class of chemicals outside of radioactive materials and explosives (both of which have high levels of political considerations).

The lack of regulatory programs and standards such as for the transportation of dangerous goods, occupational health and safety, environmental protection, emergency response planning is not just the only problem for these countries where priorities might in all fairness be more for development of the basic industrial, educational or health infrastructure, and the improvement of the standard of living of the population. The other problem may be that although there are very fine regulatory or administrative programs on the books - they are ignored or corrupted. I have come across examples of each of these: that there is no intention of implementing or seeking conformity with regulations because there are no resources or interest in doing so, or worse that the implementation forces of the agencies use their implementation powers (inspection and punishment sanctions) as a means of personal enrichment - bribes are not only accepted, they can be actively sought! (and I might add, shared with or demanded from political or bureaucratic officials further up the line).

The society

I have gained the sense that life in Latin America is a constant and general struggle - much more so than in our own society. The levels of inflation, unemployment, political instability that are common in these countries means that every individual whether rich or poor, educated or illiterate is constantly striving just to survive or to maintain their current position or level. Many public sector professionals in the countries will have two jobs and little home life in order to ensure that the family has the necessities of life. Living in these countries is a risky business and "risk taking" is a totally different both in concept and in measure from our own. For the illiterate employee who may have concerns about his personal safety, the risk is unemployment not injury or death.

The forces and behaviour of unions in these countries tend to be different from our own, and instead of seeking a balance in their activities, examples can be commonly found of the two extremes - on the one side where the union's role has been corrupted by the tight inclusion of the Union Management in the political system of the country or in the management system of the industry, to the point that the union member's interests are only given cursory attention and no support, on the other side, the union may represent the only political opposition and voice of the workers, and again the legitimate day to day needs of the employees can be lost to the overall struggle.

The lack of conventional and common (to Canadians) safety equipment can be noted on construction sites, in the condition of vehicles driven on the roads, as well as in the industrial plants. It can also be noted in the primitive and inadequate equipment available to public emergency response forces. The absence of such equipment can be attributed to a number of factors: a lack of knowledge or foresight; a lack of money to purchase them; a lack of interest; and a lack of incentive - either from a lack of regulations, or a lack of enforcement, or a lack of liability for failing to have them.

THE FUTURE

Changes are occurring in Latin America. International news, events and pressures are felt in the countries, and indeed the countries themselves are often the sources of examples that generate this news and these events. Through the medium of the international news services, these are reflected back towards the countries themselves and stimulate pressures in the countries that may not otherwise arise within them. The tragic event at Bhopal of course, immediately comes to mind, but how many of Canadians know of the 150 burned to death in a derailment in Brazil that involved gasoline tank cars, or the 500 that were killed in Mexico City in a butane storage facility, or the 50 persons killed in Uruguay from release of anhydrous ammonia in a fish processing plant, or the hundreds of thousands who each year are suffering from the mis-use of pesticides, the mis- handling of chemicals in occupational activities or from living next to these activities.

These changes are coming through a number of sources. First there are the activities of international bodies, largely supported by the developed nations who are intent on developing international standards of safety and on transferring them to the developing world. The activities of the Pan American Health Organization is but just one example of this type of activity. In my work program, I am joined with and supported by a cadre of professionals not only in the Center where I am working, but in its other Centers and Country Offices who are transferring information into the countries. Other organizations such as the World Health Organization (our parent body), the United Nations Environment Program, the International Labour Office, the International Maritime Organization, the International Civil Aviation Organization, the International Atomic Energy Agency, and the Organization for Economic Cooperation and Development are all active in this field.

The clients of these international bodies are both the governments of the countries and industry, and an influence on the governments is increasingly being achieved. This is coming not only directly through the political level meetings that take place, but through the increasing amount of material that is available through the international organizations to the government officials which then finds its way into the countries themselves. Industry is influenced through the implementation of these standards first in their home countries, and through the transfer of these standards to their subsidiaries by their own actions.

A second source of change, already mentioned, but which must be specifically acknowledged, is the activities of the multinational companies. While there are still some problems in respect to the general attitudes of the "local" management of plants in the developing countries, generally speaking the openness with which chemical safety issues are being addressed in the developed countries by industry and by the governments is being reflected in the activities of industry in Latin America. Programs similar the Canadian Chemical Producers' Association's Transport Emergency Assistance Plan (TEAP) are being mounted in a number of the countries, some in association with a chemical information center, some without. Other papers at this conference deal with the initiatives being taken by industrial associations in Colombia and in Mexico. Major chemical companies are now actively translating their MSDS's into local languages, and in the next several years, these will be completed and the sheets will be more widely distributed than they are. This type of international transfer does not take place in the industries which are more local - transportation, for example.

Finally, the third source of change is the increasing degree (and firmness) of democratization in the region means that the citizen's concerns are being expressed by opposition parties, the press and local action groups and felt by the governments and industry. Historically these have been and still are often expressed through the universities which have a strong source of knowledge and are a strong source of information and expertise. They also tend often to have a degree of political independence.

The activities of these and of developing citizens groups, whether academic ones or not are giving courage and support to the government officials who know that changes are needed and should be made. Pressures in many countries are now actively being seen that deal with the most commonly identified and understood features of chemical safety - contamination of air and water systems, and this is reflected backwards on to the other aspects of chemical safety.

CONCLUSIONS

Many aspects of the chemical safety problems of Latin America are beginning to be addressed. Training programs are being developed for use in the countries, labelling systems and Material Safety Data Sheets are being made available in the languages of the countries, environmental protection is becoming a concern and efforts are being made to diminish pollution and contamination. Chemical information centers are being established in the countries, emergency planning is being improved and emergency measures being instituted.

Given the relative economic powers of the governments and industries of the region, my conclusion is that achievements can be made by industry acting in advance of government actions - we have already seen examples of that in Mexico and in Colombia. Possibly more should be done but the absence of legislated responsibilities and financial liabilities enables the less than conscientious to avoid taking these steps.

PROJECT SETIQ

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ASOCIACION NACIONAL DE LA INDUSTRIA QUIMICA

1. INTRODUCTION

This paper presents the most relevant aspects of the project which Asociación Nacional de la Industria Quimica de México has been implementing since the end of 1987 and still developing in order to establish an emergency response center for the transportation of chemical products.

First of all, the country's general traits and its chemical industry are presented and, later, the most relevant aspects of the project's three stages called SETIQ (Emergency System in Transportation for the Chemical Industry).

2. MEXICO'S GENERAL TRAITS.

Table (1) shows a world statistical of general aspects.

As you can see Mexico has the second highest gross national product in Latinamerica, but compared with USA and Japan this value is almost 4% and 12% respectively.

Mexican Republic has as extension 80% less than the USA and it is the third largest country in Latinamerica after Brazil and Argentina.

3. THE CHEMICAL INDUSTRY IN MEXICO.

La Asociación Nacional de la Industria Química, A.C. (ANIQ) is a National Association which represents the chemical and petrochemical industries in Mexico. The ANIQ was formally constituted on November 11, 1959 with 25 affiliated companies. As of today, it has more than 300 companies, a group which represents a production volume of more than 70% of the total production of the country's chemical industry without considering the primary petrochemical production which is handled by Petroleos Mexicanos. Table (2) shows a comparative statistical of petrochemical production in order to give an idea of the industrial activity in Mexico.

The chemical industry, in a world scope, has been traditionally considered as one of the sectors of larger growth in the general context of economy. In this sense Mexico is not the exception since, in spite of negative conditions which

TABLE 1
WORLD STATISTICS

COUNTRY	AREA (KM^2)	POPULATION (Hab) Ref: 1987	RAILROADOS LENGHT-ROUTES (Km)		ROADS TOTAL LENGH (Km)		GROSS NATIONAL PRODUCT (MILLION US dls) Ref: 1985
United States	9'529,063	243'773,000	296,497	(1985)	6'214,972	(1986)	4'325,000.0
Japan	377,801	122'100,000	26,564	(1985)	1'127,500	(1985)	1'366,040.0
West Germany	248,717	60'924,000	68,082	(1986)	490,045	(1984)	667,970.0
France	543,965	55'623,000	34,676	(1985)	804,650	(1985)	526,630.0
United Kingdom	244,110	56'878,000	39,448	(1985)	348,344	(1985)	474,190.0
Italy	301,277	57'256,000	29,726	(1986)	301,307	(1984)	371,050.0
Canada	9'970,610	25'857,000	120,000	(1985)	884,249	(1984)	347,360.0
Brazil	8'511,965	141'302,000	28,942	(1984)	1'583,172	(1985)	222,010.0
Mexico	1'958,201	81,323,000	25,716	(1984)	176,738	(1985)	163,790.0
Argentina	2'780,092	31'496, 000	34,172	(1986)	211,341	(1985)	65,080.0
Venezuela	912,050	18'272,157	2,213	(1985)	75,772	(1985)	53,800.0
Colombia	1'141,748	28'665,000	3,255	(1985)	105,201	(1983)	37,610.0
Chile	756,626	12'475,000	8,107	(1985)	79,224	(1985)	17,230.0

Source: Encyclopedia Britannica Book of the Year; 1988.

TABLE 2

PETROCHEMICAL CAPACITY

(MILLION TPY)

(1987 Statistics)

COUNTRY	TOTAL
United States	102,667
Japan	31,149
West Germany	20,264
France	12,036
United Kingdom	9,148
Brazil	7,315
Mexico	5,593
Argentina	1,298
Venezuela	509
Colombia	441
Chile	106

Source: Industry News
December 1988.

affected the national economy in 1987 and 1988, the chemical industry actually kept its growth characteristics. Thus, during 1987, the industry registered an actual growth rate of 10.7 % as compared to 1980. This growth rate may be compared to the registered statistics of the years of 1979, 1981 and 1983, so this growth may be considered important when the chemical industry is compared to other industrial sectors.

Following you may find some statistical information (*) which shows the chemical industry activity in Mexico during 1987:

Total number of employees	: 126,000
Total production in volume	: 230,000 Ton/Yr
Number of chemical products	: 9,000

(*) Anuario Estadístico de la Industria Química Mexicana; 1987; ANIQ.

4. ORIGIN OF THE PROJECT SETIQ

The project called SETIQ (Emergency System in Transportation for the Chemical Industry) comes forth with the same motivations and worries which the chemical industry, worldwide speaking, has expressed about the risks inherent to the transportation of chemical products and its repercussions on environment, health and natural resources. This interest developed spontaneously from ANIQ partners, without existing any legal obligation.

In this way, ANIQ in 1987 entertained the idea of having in our country an emergency system in transportation as an element of support to the competitivity of the National Chemical Industry based on the reinforcement of safety measures in handling and transportation of dangerous goods.

5. GENERAL PLANNING OF SETIQ PROJECT

To develop the project, a consistent plan of three consecutive stages was formed: the first one focussed on the knowledge and experience of similar systems implemented in the USA and Canada, as well as becoming aware of the conditions prevailing in our country on this matter, in order to have a preliminar idea as to the impact this system might have in Mexico and the effort of modulation and adaptation, speaking in technical, legal and social terms which would be demanded by its implementation. In the second stage, the objectives would be defined with strict accuracy, as to the scope, technical characteristics, cost of the project, and all commercial and administrative structure of the SETIQ. Finally, in the third stage, the actual implementation of the project would take place.

5.1 Development of the first stage (Nov.1987 - March,1988)

An analysis of international and national experiece on this matter gave us the definition of the following elements:

(A) SETIQ'S objectives

- + Furnish the opportune, specific technical information to respond to emergencies caused by the transportation of chemical products, either by railroad or truck within Mexico.
- + Notify the shipper and the transportation company of the emergency.
- + Serve as a link with other emergency systems (only in specific cases)

(B) System's requirements

The basic elements which were identified for the operation of the system were the following:

- (a) Materials Identification System
  - + Material Safety Data Sheets (MSDS)
  - + Labels
  - + Placarding
  - + Emergency Guides
- (b) Communication System
  - + 800 Line; 24h/365 days
  - + Communicators
  - + Recorder system
  - + Phone book of public and private resources
  - + Shippers phone book
- (c) Technical Information
  - + MSDS
  - + Technical bibliography
  - + Data bank
- (d) Infrastructure
  - + Officee
  - + Computation system (software and hardware)

(C) Present Situation in Mexico

In order to identify the best way to cover the mentioned requirements in point (B), the situation which prevails in Mexico was analyzed, reaching the following conclusions:

- (a) Material Identification System:
  - + General use of labels and MSDS in exportation products.
  - + There is no Mexican regulations

Conclusion: Need to unify criteria, based on a signalization system and classification of the United Nations Organization propitiating its adoption.

- (b) Communication System:
  - + Line 800
  - + Satellite Morelos

- + PEMEX and FFCC internal net
- + Public resources phone book
- + ANIQ phone book
- + Mutual Aid groups phone book

Conclusion: Sufficient basic infrastructure to make system operable.

(c) Technical information:

- + Wide bibliography within the principal companies and investigation centers
- + Incipient development in using MSDS

Conclusion: Sufficient tecnical information; promote the use of MSDS.

(d) Infrastructure

- + Possible requirements covered: microcomputer, communication system, etc.

(D) Compatibility of the SETIQ

It was considered that the system should be compatible with:

- + National System of Civil Protection
- + PEMEX and FFCC system
- + Emergency systems in the transportation of dangerous goods of the chemical industry in Mexico :
  - - Industrias Resistol, S.A.
  - - DuPont
  - - Celanese, etc.
- + CHEMTREC and CANUTEC

5.2 Development of the second stage (April 1988-November 1988)

This stage's objective was to define the following fundamental elements in the system:

- + Establishment of material identification system
- + Hardware and software selection
- + Infrastructure definition
- + Organization and structure
- + Cost estimate
- + Financing and accounting
- + Marketing
- + Collaboration basis: authorities, National System for Civil Protection, PEMEX and FFCC.

For your information only, the most relevant characteristics of aforementioned elements are shows:

(a) Material Identification System: The guide for the ellaboration of the elements was generated:

- - Material Safety Data Sheets
- - Labels
- - Placarding
- - Emergency Guides

(b) Hardware:

- - One Vectra unit RS/20-300; RAM memory of 2Mb and one hard disk unit of 310 Mb

- Two Vectra units CS-20V; RAM memory of 640 Kb; hard disk unit of 20 Mb, these last to form a computation network.
- Document scanner
- Laserjet printer

(c) Software:
- Menu system to feed information: MSDS, labels, addresses, telephone numbers, etc.
- Information retrieval system using booleand logic to identify shipper, material and finally the obtention of MSDS.
- Communication: Telephone line 800
- Switchboard
- Telex, Telefax

(d) Human resources:
- Three communicators
- One administrator
- One supervisor
- One secretary

(e) SETIQ'S operation: See figure 1

(f) Investment cost: USD $ 271,500.00
Number of companies interested in belonging to SETIQ: 70

5.3 Development of the third stage

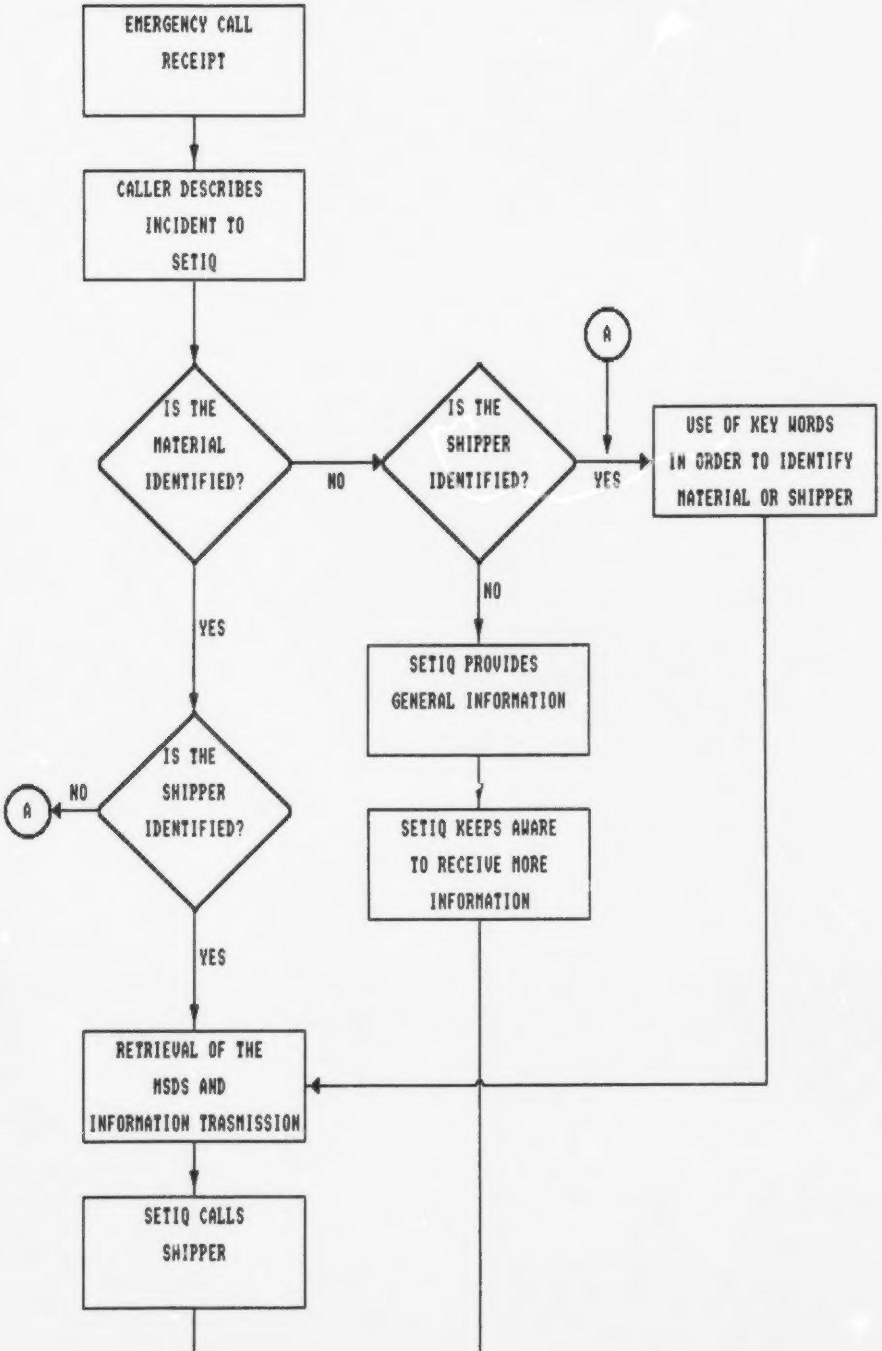
As of today, the progress of this stage is incipient, working in the financing and defining subscription dues. Considering the above, the acquisition of infrastructure will continue, as well as personnel recruiting and training, software development, system feeding and, finally, make the trials, start up and project demonstration.

6. FINAL COMMENTS

The participants in this project have had two great satisfactions which have kept a permanent motivation: first, the technical interest and the intrinsical challenge which represents a project of this type; and second, and most important, the constant support and collaboration of institutions, national and international. Among others we may cite: Chemical Manufacturers Association, Centro Panamericano de Ecología, Sistema Nacional de Protección Civil, Secretaría de Desarrollo Urbano y Ecología, Petróleos Mexicanos, Ferrocarriles de México and Industrias Resistol,S.A.,specifically, Leopoldo Rodríguez, ex-president of ANIQ, whose vision and feeling played a key part in the promotion and approval of the project; we have to mention also Joe Mayhew from CMA, Duncan Ellyson from ECO and René Altamirano from SEDUE. From all of them we have received valuable knowledge, experiences and support.

FIGURE 1

OPERATION SCHEME OF SETIQ


EMERGENCY CALL RECEIPT
CALLER DESCRIBES INCIDENT TO SETIQ
IS THE MATERIAL IDENTIFIED?
NO
IS THE SHIPPER IDENTIFIED?
YES
A
USE OF KEY WORDS IN ORDER TO IDENTIFY MATERIAL OR SHIPPER
NO
YES
SETIQ PROVIDES GENERAL INFORMATION
IS THE SHIPPER IDENTIFIED?
NO
A
SETIQ KEEPS AWARE TO RECEIVE MORE INFORMATION
YES
RETRIEVAL OF THE MSDS AND INFORMATION TRASMISSION
SETIQ CALLS SHIPPER
SETIQ CALLS PUBLIC ASSISTANT GROUPS

The amount of experience on which this project is based has required a minimun of human resources (three persons in part time).

In synthesis, we are really enthusiastic in pushing this project. We are aware that this is only the beginning and that there will be multiple challenges to be met to make this project a reality, so as to make Mexico participate in this field and face the needs of its chemical industry which is an example of the Mexican industrial sector.

AN EXPERIENCE IN CHEMICAL EMERGENCY PREPAREDNESS IN A DEVELOPING COUNTRY

ALFONSO ROJAS

CONSEJO COLOMBIANO DE SEGURIDAD
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PAPER UNAVAILABLE AT TIME OF PRINTING

RESPONSE AND ENVIRONMENTAL MONITORING DURING THE CANNING PESTICIDE WAREHOUSE FIRE

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ABSTRACT

This paper provides comprehensive information on the environmental response to a fire at the pesticide warehouse in Canning, Nova Scotia on 31 May, 1986. The incident is described in detail.The roles and activities of the agencies involved are discussed and observations made. Results of the sampling, analytical and clean-up efforts are highlighted. Pesticide levels in milk,drinking water,run-off water, soils, biota and in the Habitant River are provided.

INTRODUCTION

In the early morning hours of May 31, 1986 a fire broke out at Maple Leaf Farm Supplies Limited pesticide warehouse situated on Main Street Canning, Nova Scotia. A large variety and quantity of agricultural products (Table 1) including pesticides, herbicides, fumigants and fertilizers were stored in the building along with seed grains, seed and table potatoes, propane cylinders and miscellaneous farm machinery.

During firefighting operations an estimated 1.2 million litres of water was used; much of this contaminated water migrated off site passing over adjacent residential properties, into a farmers pond and eventually finding its way into the Habitant River via drainage ditches and storm drains.

Vegetation and large numbers of worms were killed in the path of the water and fish and invertebrates died in a local farmers pond as well as downstream in the Habitant River.A trench was dug to intercept contaminated run-off and wash water during the clean-up phase however, this trench was constructed after the bulk of fire fighting water had left the site.Roughly 100,000 litres of water was treated by a membrane filtration process known as reverse osmosis to remove contaminants prior to discharge.

Top -Burned out warehouse,drums for clean-up in foreground.
Bottom -Clean-up underway,senior citizen's home upper right.

TABLE 1 - LIST OF PESTICIDES STORED IN MAPLE LEAF WAREHOUSE

PRODUCT	ACTIVE INGREDIENTS	TOTAL AMOUNT
Agrox PSP 16%	Mancozeb	640 kg
Agrox DL Plus	Captan/Diazinon/Lindane	9.75 kg
Amiben	Chloramben	22.7 kg
APM (Guthion)	Guthion	248 kg
Atra Mix	Atrazine	480 l
Atrazine	Atrazine	1130 l
Banvel	Dicamba/Mecroprop/2,4-D	70 l
Basudin	Diazinon	32 l
Benlate	Benlate	12 kg
Bravo	Chlorothalonil	720 l
Captan 50 WP	Captan	300 kg
Cymbush	Cypermethrin	6 kg
Decis	Deltamethrin	30 l
Dikar	Mancozeb	450 kg
Dipel	*Bacillus Thuriengiensis*	36 kg
Di-Syston 15G	Disyston	100 kg
Dual 960 E	Metolachlor	40 l
Easeout PSP	Thiophanate-Methyl	60 kg
Eptam 8E	EPTAH	40 l
Equal	Dodine	38 kg
Furadan 4.8	Carbofuran	228 l
Gramoxone	Paraquat	115 l
Lannate	Methomyl	75.6 l
Lexone DF	Metribuzin	30 kg
Malathion 50 EC	Malathion	80 l
Manzate	Maneb	1212 kg
MCPA	MCPA	10 l
Monitor	Methanidophos	50 l
Patoran	Metobromuron	130 l
Phygon	Phygon	100 kg
Plictran 50 WP	Cyhexatin	10.5 kg
Polyram 80	Metiram	1000 kg
Primextra	Metolachlor	190 l
Ripcord	Cypermethrin	6 l
Pival	Pindane	54 l
Sutane 8E	Butylate	500 l
Sutazine	Atrazine	80 l
System	Demetron	40 lkg
Temik	Aldicarb	615 kg
Terraklene	Paraquat	40 l
2,4-D 500	2,4-D	145 l
Vapam	Metam-Sodium	2010 l

TABLE 2 - AGENCY ROLES DURING THE CANNING RESPONSE

Emergency Measures Organization,Kings County:
- Overall onscene coordination
- Coordination of public relations
- Coordination of municipal services/housing and feeding evacuees
- disposal of non-contaminated warehouse debris

Nova Scotia Department of the Environment:
- Lead environmental agency responsible for overall coordination of clean-up and disposal effort
- Negotiation with pollutor and industry association

Canning Fire Department:
- Local onscene command
- Directing mutual aid firefighting efforts
- Initiation of evacuation

RCM Police:
- Maintaining site control
- Assisting in evacuation of residents

Environment Canada:
- Provision of technical advice and assistance during clean-up and disposal
- Collection of water,soil and vegetation samples
- Coordination and laboratory analysis (NRC,EC,DFO and Agriculture Canada analyzed Canning samples)
- Use of reverse osmosis to process contaminated water

Nova Scotia Department of Health:
- Provision of advice on health implications of incident
- Sampling and analysis of water from municipal and private wells
- Blood and urine analyses of response personnel

Nova Scotia Fire Marshall:
- Investigation of cause of fire

Canadian Agricultural Chemical Association:
- Member companies recovered undamaged or identifiable products
- Arranging and funding final clean-up of residues by the contractor Sanexen International

Department of Fisheries and Oceans:
- Survey of Habitants River
- Analysis of pesticides in fish and shellfish

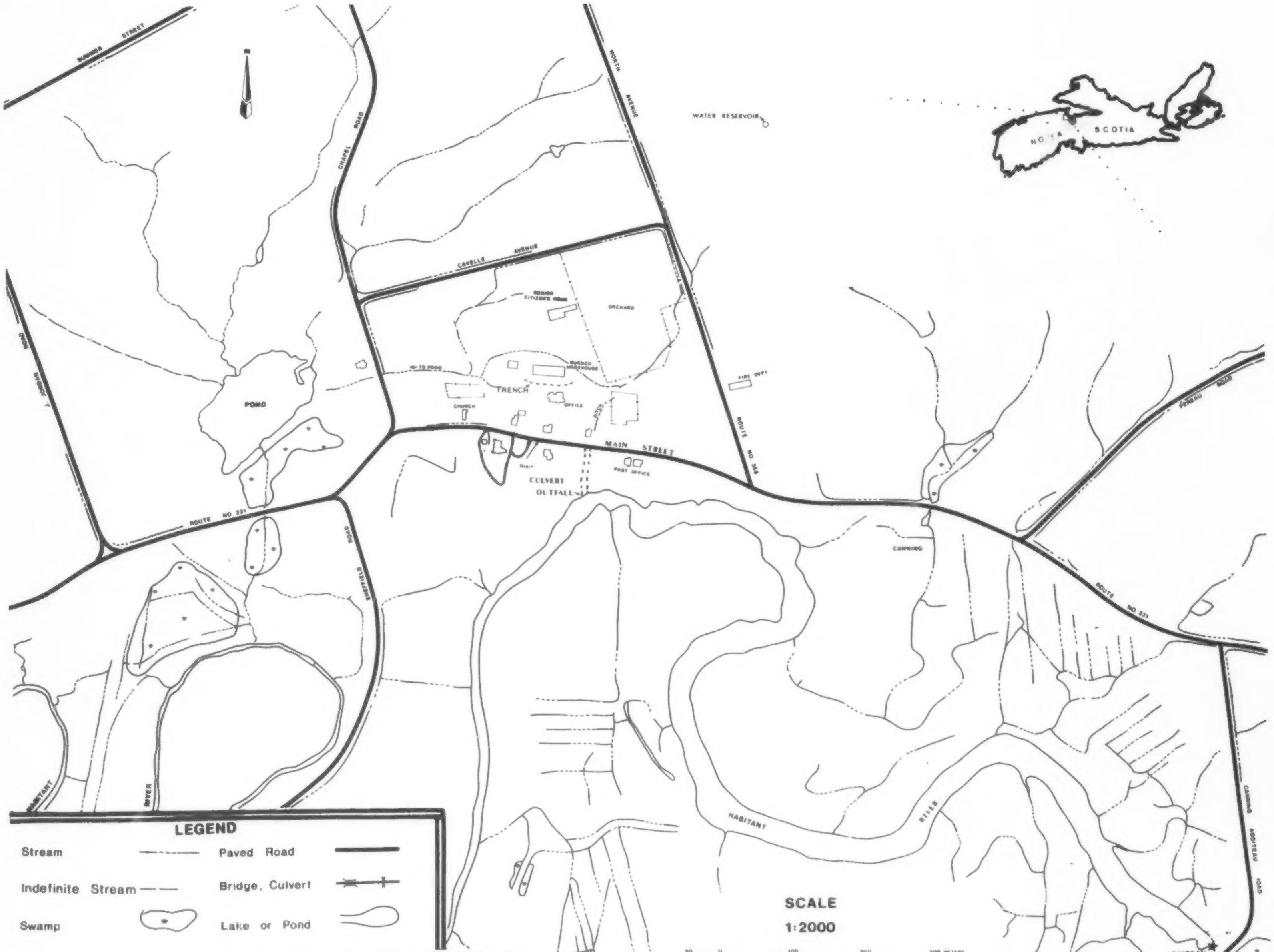

SUMMER STREET
CHAPEL ROAD
NORTH AVENUE
WATER RESERVOIR
NOVA SCOTIA
CAVELLE AVENUE
SENIOR CITIZEN'S HOME
ORCHARD
TO POND
BURNED WAREHOUSE
TRENCH
CHURCH
OFFICE
DITCH
FIRE DEPT
ROUTE NO 358
POND
JORDAN ROAD
ROUTE NO 221
MAIN STREET
Drain
POST OFFICE
CULVERT
OUTFALL
SHEFFIELD ROAD
CANNING
PEREAU ROAD
HABITANT
RIVER
HABITANT RIVER
CANNING ABOITEAU ROAD
ABOITEAU
LEGEND
Stream
Indefinite Stream
Swamp
Fence
Paved Road
Bridge, Culvert
Lake or Pond
SCALE
1:2000
50
0
100
200
300 METERS

Figure 1 - The village of Canning, Annapolis Valley, N.S.-Site of a May 31, 1986 Pesticide Warehouse Fire.

Several hours after the fire was discovered municipal and local fire and police officials began evacuating the village of Canning; residents living closest to the fire site were not permitted to return to their homes for six days. A multidiciplinary emergency response and clean-up effort was immediately initiated.

This paper highlights the early phases of the response which was mounted (refer to Table 2 for a brief description of agency roles and responsibilities during this incident), provides a detailed account of the environmental sampling and analytical program conducted and the results of that sampling effort. The clean-up of debris and treatment of contaminated water is also described.

THE SPILL SITE

Canning is a small rural community of approximately 750 people located in Kings County in the predominantly agricultural Annapolis Valley of Nova Scotia(Figure 1). The village is some 10 kilometers from Kentville, the site of the County offices designated as headquarters for the spill response.Main Street closely parallels the Habitant River which flows 1.5 kilometers to an abateau at its confluence with the Minas Basin. The Maple Leaf Farm Supplies Limited warehouse was a metal-sided structure on a concrete pad situated on a hill overlooking Main Street. The pesticides were stored in a variety of metal, plastic and paper containers. A large number of propane cylinders and two of gaseous methyl bromide were also present: the contents of the latter were not released during the fire. A nearby retail outlet containing a variety of farm products was undamaged by the fire.The inventory records for the warehouse were kept in this building and were therefore not destroyed in the fire.

RESPONSE, CONTAINMENT AND CLEAN-UP INITIATIVES

The local volunteer fire service responded to the call at 0200 hours on May 31,1986: following an assessment of the situation the fire chief requested and received mutual aid assistance from other volunteer departments. He also contacted Transport Canada's CANUTEC office to obtain information on potential hazards of products suspected to be involved in the fire.

Municipal and Kings County officials were promptly advised and they invoked the County Emergency Response Plan which fortunately had been thoroughly tested only days before the fire.By 0300 hours an evacuation of local residents by firefighters and RCM Police was underway.A senior citizens home was situated very close to the fire site.ollowing the evacuation access to the entire area was restricted to those involved in responding to the incident.

At 0319 hours CANUTEC relayed information on the spill to the Regional Pollution Reporting System(Canadian Coast Guard Traffic Centre) who in turn informed Nova Scotia Department of Environment and Environment Canada,and subsequently other interested agencies.Representatives of environmental agencies were on-scene by 0530 May 31,1986.

Twenty-three firefighters and police officers and one local resident were treated in hospital for possible exposure to chemical fumes and then released.

As mentioned previously in excess of 1.2 million litres of water was used to control the fire,much later foam was also applied; contaminated water left the immediate site(Figure 2) passing over adjacent properties. A trench was dug to trap water leaving the immediate fire area.

The NS-Fire Marshall's office and RCMP initiated an intensive investigation into the cause of the fire since there had been a number of suspicious fires in the Annapolis Valley over the preceeding weeks and months.The Fire Marshall retained control of the site for five days;this did not,however impede the monitoring and clean-up activities taking place there.

Environmental agencies worked closely with the warehouse owner to develop a detailed and current inventory of products in the building and with product manufacturers to determine the safest and most appropriate containment,neutralization and clean-up procedures.

Response teams from pesticide manufacturers came on-scene both to provide technical advice and to recover identifiable products for disposal or re-use.

Environmental samples were collected by Environment Canada and several laboratories placed on alert to evaluate samples on a priority basis.The analyses undertaken and the coordination of this effort are discribed elsewhere in this paper.

The Fundy Health Unit of the provincial Health Department placed an immediate restriction on the use of the municipal water supply until testing confirmed its safety on June 5th.However,an advisory remained in effect after this date for five private wells in the area.The Health Department also coordinated a blood/urine sampling program (acetylcholinesterase,liver and kidney functions) for response crews and others potentially exposed to chemicals.The results of this extensive testing showed no abnormalities.Milk was collected from local dairy herds for pesticide residue analysis and cattle in the immediate area were given blood tests and placed under veterinary observation as a precaution.

On June 03,1986 N.S.-DOE issued a Ministerial Order requiring a thorough clean-up of the site by the polluter The warehouse owner was unable to fund on his own such a large-scale operation .Following the invocation of the Good Samaratan Act by the province the Canadian Agricultural Chemical Association (now known as Crop Protection Institute

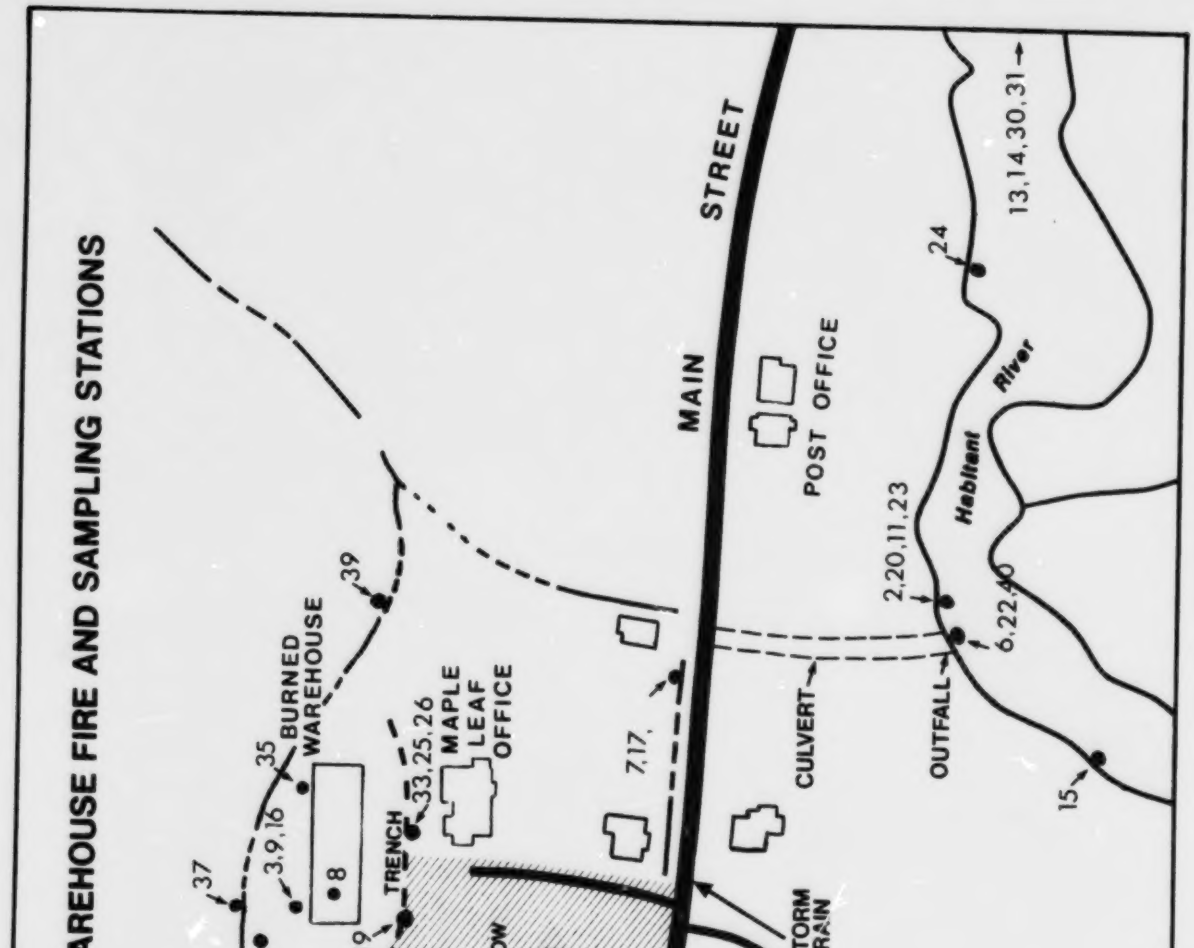

AREA ADJACENT TO WAREHOUSE FIRE AND SAMPLING STATIONS
N
5,8,12,29
TO POND
27
38
1,21
34
37
3,9,16
35
8
BURNED WAREHOUSE
39
Silos
28
4,10,19
TRENCH
33,25,26
MAPLE LEAF OFFICE
OVERLAND FLOW OF RUNOFF
7,17,
CHURCH
MAIN STREET
STORM DRAIN
DRIVEWAY
CULVERT
POST OFFICE
OUTFALL
2,20,11,23
6,22,40
24
15
Habitant River
13,14,30,31
Legend
● SAMPLING STATION
— - — DITCH
Scale
500 m
0
500 m

Figure 2 - Water Sampling Locations.

of Canada) agreed on behalf of the industry to fund the clean-up and ultimate disposal of contaminated building debris and the remaining "chemical soup". Environment Canada assisted in the clean-up efforts by providing a mobile reverse osmosis unit to treat contaminated water.

Debris was segregated;uncontaminated building materials were disposed of at the local landfill site while pesticide residues,contaminated debris and used filters from the reverse osmosis process were drummed and disposed of at an approved out of province hazardous waste facility(discussed later in greater detail).

Regular media briefings were conducted throughout the incident and the media were allowed on site in a controlled manner for picture taking opportunities.Meetings were held with affected residents to provide them with detailed information on the nature of the spilled chemicals,possible health and environmental implications and to give them an opportunity to air any concerns they may have had with respect to the evacuation,response,and clean-up activities.

The evacuation order for residents in the immediate area of the fire was not lifted until the evening of June 06,1986 following an opportunity for those most directly affected to question environmental and health authorities on their findings.

ENVIRONMENTAL SAMPLING AND ANALYSIS

Sampling Methodologies:

Water Samples: The first water samples were obtained within nine hours of the fire.The initial samples (W1 to W22) were collected in ponded water areas in and directly adjacent to the scene of the fire,in the trench which was dug to retain runoff water,in ditches which led to the Habitant River and in the Habitant River itself (Figure 2).These samples were collected in 500 ml clear glass wide mouthed jars which had previously been detergent washed,rinsed with distilled water and rinsed with pesticide grade hexane.The jars were capped with metal screw tops whose liners had been wrapped in hexane rinsed aluminum foil.

A second set of water samples(W23 to W40) taken from the same locations was obtained within 24 hours of the first set(Figure 2).These samples were collected in 1 litre amber,narrow necked bottles which had previously been prepared as described above.The bottles were capped with metal screw tops whose liners had been wrapped in hexane rinsed aluminum foil.

Water samples were taken in duplicate.They were placed in coolers and transported to the Environmental Protection

(E.P.)laboratory where they were sorted according to their destination for analysis.Samples analysed at the EP laboratory were extracted within 24 hours of receipt and processed according to the methods described in the following section.Samples to be analyzed at Agriculture Canada and Environmental Protection labs in Ontario and the Department of Fisheries and Oceans lab in St. Andrews,New Brunswick were shipped by air,in coolers.They were received by these labs within two days of collection and were analyzed according to methods described later.

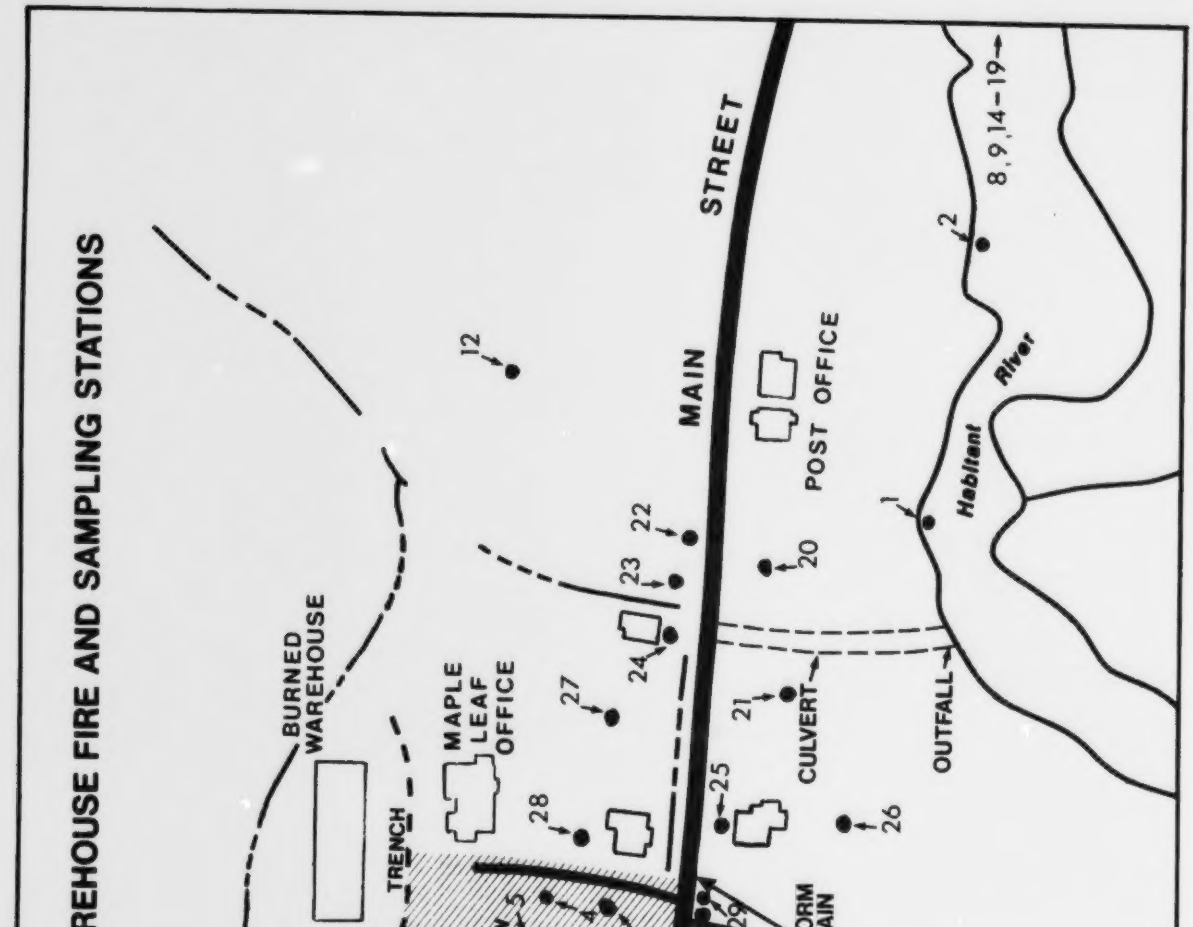
Photograph - Sampling ponded water behind warehouse.

Soil / Sediment / Vegetation Samples: Soil and sediment sampling was initiated one day after the fire at locations where water used to fight the fire had flowed (Figure 3 & 4). Sediment samples(cores) were obtained from the ditches which had carried off fire-fighting water and from the substrate of the Habitant River which received this run-off. At the time of the fire there was also a considerable amount of overland flow across the properties of landowners adjacent to the Maple Leaf Farms property,and soils from these locations were obtained at this time. Another set of sediment samples was obtained four days after the fire from the marine areas below the Habitant River aboiteau and from a farmers pond west of the warehouse. A final set of soil samples from adjcent properties was obtained seven days after the fire.

Sediment and soil samples (S1 to S11 and S13 to S40) were obtained in duplicate by either "coring" or "grabbing". Core samples were taken by driving 2.54 cm I.D. teflon core tubes into the substrate with a mallet and withdrawing them slowly.Tubes used to obtain samples had been previously detergent washed and rinsed with distilled water and hexane.Each end of the core tubes were capped with polypropylene caps that were lined with hexane rinsed aluminum foil. Using this method,substrate cores of 15 to 30 cm were obtained,however only the top 5 cm was analyzed for pesticide content.Grab samples were taken by scraping up the top 3 to 5 cm of exposed mineral soil,using a stainless steel scoop, into clear glass wide mouth jars which had been cleaned in the same way as those used for water sampling.

Sediment and soil samples were placed in coolers and transported to the EP lab,where they were immediately frozen and stored at -20'C until analyzed.Sediment and soil analyses for pesticide content were undertaken by the Agriculture Canada lab in Ottawa or EP lab in Dartmouth N.S.

One day after the fire a number of soil and vegetation samples were obtained from locations judged to be within the zone of influence of particulate fallout from the smoke plume as well as from the lawns of adjacent property where the fire-fighting water had run.Samples were obtained in duplicate by grab sampling exposed soil from areas with no vegetation canopy as previously described and by clipping vegetation in wide mouth jars which had been cleaned as previously noted.Samples were placed in coolers and transported to the EP lab in Dartmouth,where they were frozen within 19 hours of sampling.They were sorted and shipped in a frozen state to the National Research Council of Canada lab in Halifax where they were subject to a GC/MS screen for pesticide content, to the Agriculture Canada lab in Ottawa where they were subject to the same screening process,or to the EP lab in Ottawa where they were analyzed for polychlorinated dibenzo dioxin (PCDD) and polychlorinated dibenzo furan (PCDF) content.A second set of samples for PCDD/PCDF analyses were obtained for the EP lab in Ottawa seventeen days after the fire.


AREA ADJACENT TO WAREHOUSE FIRE AND SAMPLING STATIONS
BURNED WAREHOUSE
TRENCH
MAPLE LEAF OFFICE
OVERLAND FLOW OF RUNOFF
Silos
CHURCH
TO POND
MAIN STREET
POST OFFICE
CULVERT
OUTFALL
STORM DRAIN
DRIVEWAY
Habitant River
8,9,14–19
Legend
SAMPLING STATION
DITCH
Scale
500 m
0
m 500
1
2
3
4
5
6
7
10,11,31
12
20
21
22
23
24
25
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40
N

Figure 3 - Grab and Core sediment Sampling Locations.

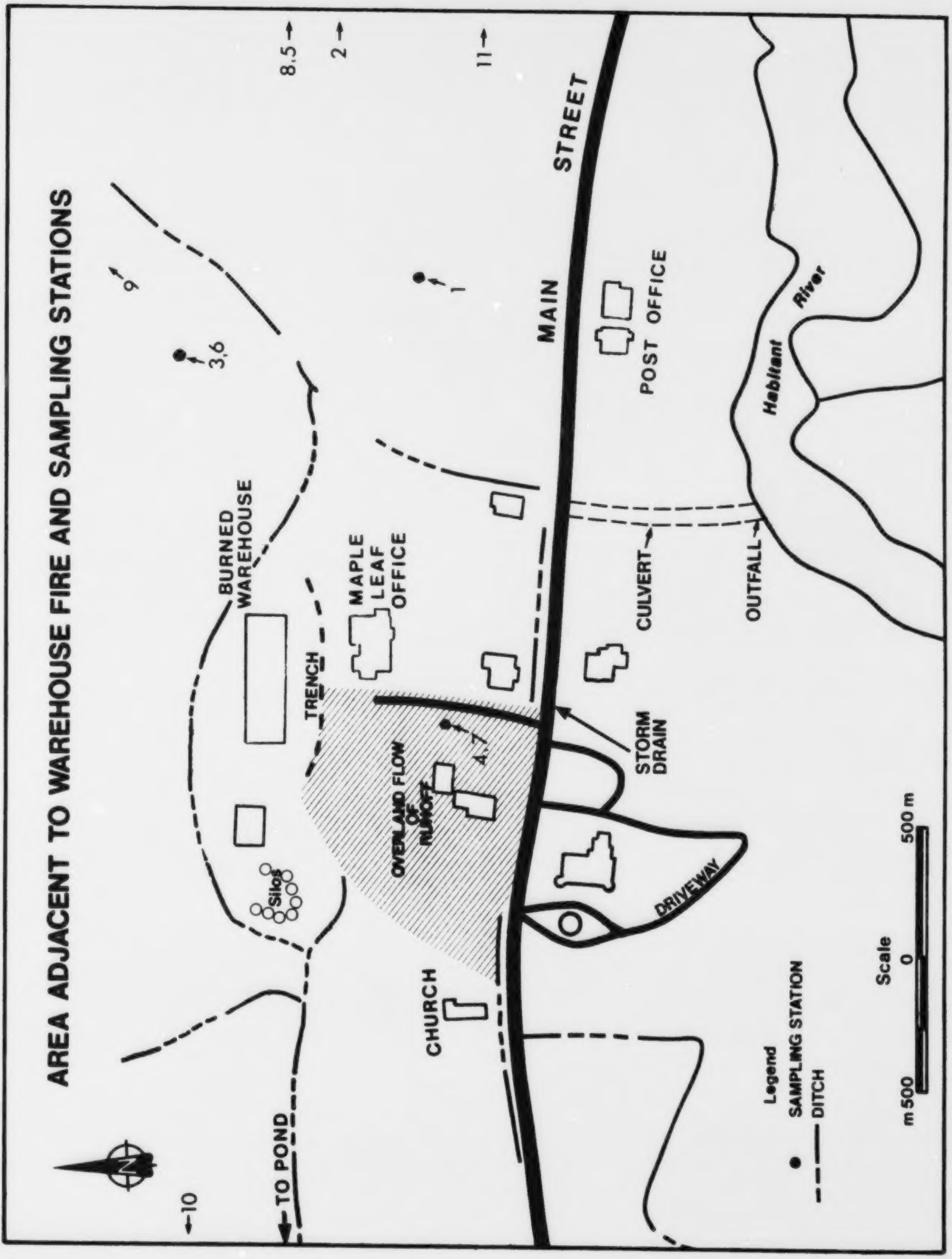
AREA ADJACENT TO WAREHOUSE FIRE AND SAMPLING STATIONS
N
TO POND
10
8,5
2
11
9
3,6
1
4,7
BURNED WAREHOUSE
MAPLE LEAF OFFICE
TRENCH
Silos
OVERLAND FLOW OF RUNOFF
CHURCH
MAIN STREET
POST OFFICE
CULVERT
OUTFALL
STORM DRAIN
DRIVEWAY
Habitant River
Legend
● SAMPLING STATION
— — DITCH
Scale
m 500
0
500 m

Figure 4 - Vegetation Sampling Locations.

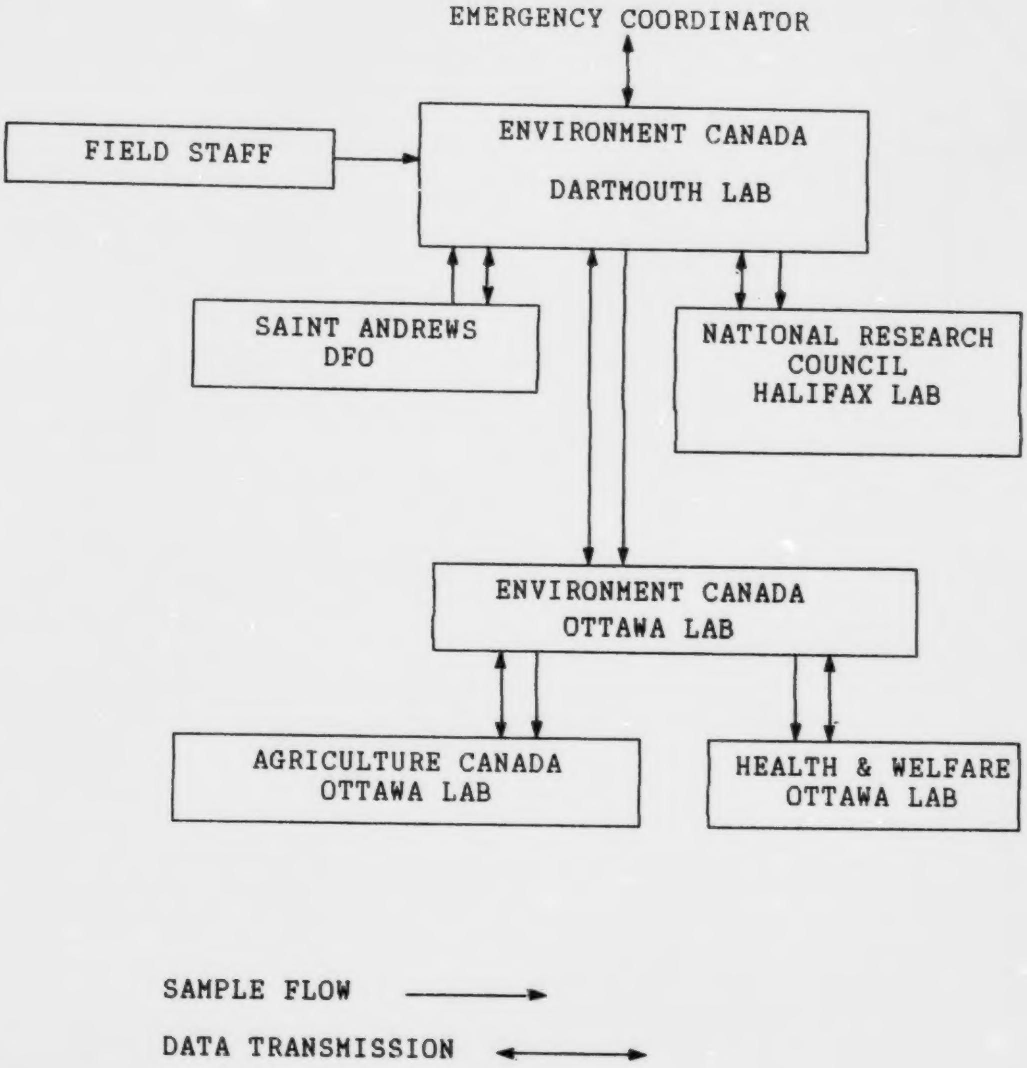
EMERGENCY COORDINATOR
FIELD STAFF
ENVIRONMENT CANADA DARTMOUTH LAB
SAINT ANDREWS DFO
NATIONAL RESEARCH COUNCIL HALIFAX LAB
ENVIRONMENT CANADA OTTAWA LAB
AGRICULTURE CANADA OTTAWA LAB
HEALTH & WELFARE OTTAWA LAB
SAMPLE FLOW
DATA TRANSMISSION

Figure 5 - Coordination of Laboratory Analyses.

Milk Samples: At the request of local health authorities several milk samples were obtained from the dairy farm closest to the Maple Leaf Farm Supply Limited property.The samples were collected two days after the fire from a batch milking of a herd which grazed approximately 1.5 km S.E. of the fire site. These samples were taken in one litre amber glass bottles and transported to the EP lab in Dartmouth, where one sample was extracted within twelve hours of receipt for pesticide analysis and one sample was shipped fresh,by air,to the EP lab in Ottawa for PCDD/PCDF analysis.

Fish and Shellfish Samples: Winter Flounder (*Pseudopleuronectes americanus*) caught in the Minas Basin and clams (*Mya arenaria*) dug at the shore near the mouth of the Habitant River mouth within three days of the fire were frozen and shipped in coolers to the Department of Fisheries and Oceans Lab in St. Andrews,N.B. for analysis.

Laboratory Coordination:

It became immediately obvious that no single lab could handle the large number and variety of samples required to be analyzed when 45 agricultural chemicals/pesticides are involved.Particularly when there is an urgent need for environmental data on which to base decisions on short and long-term environmental impacts,to priorize clean-up and to assess the adequacy of clean-up.

Environment Canada has an in-house capability in Dartmouth for analyzing most of the parent pesticide compounds encountered in a spill situation however assessment of combustion products such as dioxins and furans had to be carried out by other labs.In addition DFO agreed to examine pesticide residues in tissue samples from clams and flounder collected near the mouth of the Habitant River.

A lab coordination system was established at EP in Dartmouth(Figure 5).This centre was responsible for selecting those labs to assist in the analysis,sample splitting to ensure quality control,preparation and shipping of samples,advising labs of requirements and data verification(qualitative and quantitative).The main considerations in carrying out the analyses and lab selection were minimal sample handling,reasonable shipping distance,reliable data and quick turn-around.In addition the Dartmouth EP-lab carried out analyses of milk,water,and soil/sediment samples.

Analysis of Samples:

Water Samples: Immediately upon arrival at the EP regional lab 100-800 ml of water was made to pH 8.5 with sodium carbonate solution. The water was extracted twice with 100 ml of dichloromethane,the extracts were pooled and dried over anhydrous sodium sulphate.The dried extracts were concentrated by vacuum evaporation to about 10 ml,then 1-2 ml under a nitrogen gas stream and finally the dichloromethane was exchanged with acetone.The concentrated extract,labelled fraction 1,contained any base-neutral pesticides present in the water samples(eg. atrazine,butylate,deltamethrin).Fraction 1 was immediately screened by gas-liquid chromatography.

The remaining water at pH 8.5 was made to pH 3.0 with concentrated sulphuric acid and re-extracted twice with 100 ml of dichloromethane.The solvent extracts were combined,dried and concentrated to 1-2 ml.The concentrate was labelled fraction 2 and stored at 4'C for future derivatization and GC screening if required.Fraction 2 contained acidic peticides(eg. 2,4-D,MCPA,Mecoprop).

Drinking Water Samples: The Fundy Health Unit of the Nova Scotia Department of Health tested water samples from the Canning public water supply.These samples were collected in solvent rinsed bottles and extraction conducted using standard base-neutral and acid protocols.All samples were stored at 4'C prior to extraction.Sample extracts were analyzed by electron capture gas chromatography prior to evaluation by GC/MS(Dr.J.Prenciss).

Municipal water supplies are regularly screened for a broad range of water quality parameters ,including pesticides,by the Water Quality Branch of Enviroment Canada (personal communication - Mr. H.O'Neill).It was fortuitous that the two Canning water supply wells were scheduled to be evaluated on June 5 and again on September 24,1986.Pesticides were quantitated using high performance liquid chromatography and post column derivatization.

Soil and Sediment Samples: Frozen soil or sediment samples retained by Environment Canada (Dartmouth Lab) for analysis were thawed and 10-15 g weighed out and well mixed with 20 g of anhydrous sodium sulphate.In the case of core samples,the first 0-3 cm was used.The soil mixture was transferred to a soxhlet extraction apparatus and exhaustively extracted with 150 ml of dichloromethane for eight hours.The dichloromethane was extracted with 300 ml of water at pH 8.5. This water was extracted with 50 ml of dichloromethane which was added to the original 150 ml of dichloromethane.The water phase was collected and saved.The pooled dichloromethane (200 ml) was dried over anhydrous sodium sulphate,concentrated and exchanged with acetone.The concentrated extract,fraction 1,was examined for base-neutral pesticides by gas-liquid chromatography as described below.The saved water phase (pH 8.5) was made to pH 3.0 with sulphuric acid and back extracted twice with 100 ml of dichloromethane.The extracts were combined,dried,concentrated to 1-2 ml and stored for future derivatization of acidic pesticides if required.

In analyzing soil samples the National Research Council Lab in Halifax utilized the following extraction techniques prior to clean-up and analysis with GC/MS (P.Sim -personal communication):

- -basification with 10 % sodium carbonate solution and extraction with methylene chloride ,
- -acidification with 50 % sulphuric acid and extraction with methylene chloride,
- -methyl chloride extraction of the material as received,
- -extraction with acetone/hexane,
- -extraction with diethyl ether/methanol.

Milk Samples: Fifty grams of milk was carefully weighed and transferred to a graduated cylinder and 100 ml of acetonitrile added.The mixture was allowed to settle overnight.The supernatant was removed and exactly half the supernatant volume was transferred to a separatory funnel containing 200 ml of sodium chloride saturated water.The water-acetonitrile mixture was extracted twice with 100 ml of dichloromethane.The extracts were combined,dried over anhydrous sodium sulphate,concentrated and the dichloromethane exchanged with acetone.The concentrate was used for gas chromatographic analysis without further preparation.

Fish and Shellfish Samples: Three samples of clams taken from the shores of Minas Basin at the confluence of the Habitant River,pooled sample of livers from four winter flounders and viscera from one flounder caught by commercial fishermen in Minas Basin were analyzed by gas chromatography-mass spectrometry,after routine clean-up of the extracts(V.Zitko - personal communication).Pesticides that have previously been shown to be taken up by aquatic biota were investigated.These were carbofuran,methoxychlor,metobromuron,linuron,atrazine, trifluralin,diclone,butylate,malathion,dimethoate,EPTC, permethrine,cypermethrin,metribuzin,bromoxynil and captan.

Gas Chromatographic Screening of Base-Neutral Pesticides: Samples were examined for nine of the possible forty-five pesticides stored at the Canning warehouse.Pesticides selected for screening were chosen according to the quantity in the warehouse at the time of the fire,the water solubility and toxicity of individual compounds,persistence in the environment,and the availability of reference standards The nine pesticides screened in samples were: aldicarb, aldicarb sulphone,carbofuran,atrazine,butylate,guthion, cypermethrin, fenvalerate and deltamethrin.

Water and soil/sediment extracts were analyzed on an HP

5880 gas chromatograph equipped with a thermionic specific detector (nitrogen-phosphorous) and a fused silica capillary column (DB-5 30m x0.32 mm ID).Quantitative and qualitative analysis was accomplished by external standardization. Additional qualitative confirmation was provided by re-examining selected samples by gas-chromatography equipped with electron capture detection.

Vegetation Samples: The Environment Canada Lab in Ottawa analyzed vegitation samples by first air drying and weighing the material followed by shaking and soaking with methylene chloride for one hour.The raw extracts were then passed through three columns to remove the bulk of the organic material co-extracted with target compounds.The processed extracts were finally concentrated to 0.1 ml and analyzed by GC/MS using the selective ion monitoring technique (C.Chiu - personal communication).

RESULTS AND DISCUSSION OF ENVIRONMENTAL SAMPLING PROGRAM

GC/MS screening of the liguid "ponded" in the centre of the burned out warehouse and the standing water behind the warehouse (Table 3) indicate that there were at least 15 different pesticide residues present in significant concentrations.Butylate,atrazine,2,4-D acid,dicamba,methomyl, aldicarb,carbofuran and dithiocarbamate fungicides were detected in most of the samples and in the highest concentrations.These were also the pesticides reported to be stored in large quantities within the warehouse(Table 1).This confirms that pesticide products were solubilized or suspended in firefighting water and transported off the site. It is interesting to note that the pesticide vapam was present in large quantities in the warehouse,however,due to its high flamability it was not observed in any of the samples taken.

The dithiocarbamate fungicides (maneb and mancozeb) were in particularly high concentrations in the sample from the centre of the warehouse where an estimated 1200 and 1100 kg respectively of these products had been stored.These two products contain the metals manganese and zinc(normal background levels for local waters are 0.5 and 2.0 mg/l).Elevated levels(Table 4) in samples from a small brook behind the warehouse,pooled water behind the warehouse,a trench in front of the warehouse and from a roadside ditch confirm that these fungicides were also carried off with the firefighting water.

A number of pesticides were selected for detailed gas-chromatographic analysis to act as tracers of pesticide movement.Based on criteria outlined in the previous section the pesticides aldicarb,carbofuran,atrazine and maneb/mancozeb were selected as suitable tracers of pesticide export to water courses adjacent to the site.There were

TABLE 3 - PESTICIDE CONTENT OF WATER SAMPLES (mg/l), INITIAL SCREENING-DAY OF FIRE (MAY 31, 1986).

	Sample and Location				
Compound	W 8 Centre of Warehouse	W 9 Pool Behind Warehouse	W 10 Trench in Front of Warehouse	W 11 Habitant R. Below Culvert	W 12 Farmers Pond Outlet
Butylate	272	60.0	3.0	L 1.0*	L 1.0
Atrazine	3750	30.0	6.0	L 1.0	L 1.0
Elemental Sulphur	L 1.0	10.0	L 1.0	L 1.0	L 1.0
Malathion	L 1.0	8.0	L 1.0	L 1.0	L 1.0
Metobromuron	L 1.0	6.0	L 1.0	L 1.0	L 1.0
Metribuzin	L 1.0	6.0	L 1.0	L 1.0	L 1.0
Metolachlor	L 1.0	4.0	L 1.0	L 1.0	L 1.0
Dimethoate	L 1.0	2.0	L 1.0	L 1.0	L 1.0
Simazine	L 1.0	2.0	L 1.0	L 1.0	L 1.0
2,4-D Acid	13.0	236.0	3.0	L 1.0	L 1.0
Dicamba	150.0	12.0	8.0	L 1.0	L 1.0
Methomyl	3.0	110.0	0.1	0.1	L 0.01
Aldicarb	0.5	1.0	2.0	0.03	L 0.01
Carbofuran	1.0	2.0	0.3	0.03	L 0.01
Carbaryl	L 0.01	0.05	L 0.01	L 0.01	L 0.01
Fungicides	9.9%**	n.d	-	-	-

Analyses conducted by Agriculture Canada
* -Less than the detection limit
** -Dithiocarbamate Fungicides
n.d -not detected

TABLE 4 - MANGANESE AND ZINC CONTENT OF WATER SAMPLES - DAY OF FIRE (MAY 31,1986).*

Sample #	Location	Manganese (mg/l)	Zinc (mg/l)
W 1	Brook behind warehouse	3.61	0.38
W 2	Stream below culvert	0.28	0.04
W 3	Pool behind warehouse	16.5	4.47
W 4	Trench-front of warehouse	122	11.7
W 5	Inlet to farmers pond	0.60	0.23
W 6	Culvert outfall-Habitant R.	0.94	0.24
W 7	Ditch,north side of street	1.67	0.61

* Analyses conducted by EP-Laboratory,Dartmouth

TABLE 5 - PESTICIDE CONTENT OF WATER SAMPLES -DAY OF FIRE *

Sample#	Location	Aldicarb (mg/l)	Carbofuran (mg/l)	Atrazine (mg/l)	Maneb/ Mancozeb (mg/l)
W 13	Above aboiteau	0.007	0.007	0.1	-
W 14	Above aboiteau	0.008	0.008	0.120	-
W 15	Habitant River above influence	L 0.001+	L 0.001	L 0.001	-
W 16	Pool behind warehouse	3.2	7.9	46.0	176.0
W 17	Ditch north side Main St.	0.7	0.9	1.8	22.4
W 18	Inlet to farmers pond	7.4	0.5	9.4	7.2
W 19	Trench-front of warehouse	5.0	0.7	9.6	28.0
W 20	Habitant River below culvert	0.017	0.025	0.6	L 0.001
W 21	Ditch behind warehouse	3.3	~	19.7	4.0
W 22	Culvert outfall	0.13	-	0.06	4.0

* Analyses conducted by EP-Laboratory,Dartmouth

+ Indicates less than detection limit

~ G.C. peak not clearly identifiable

measurable quantities (Table 5)of these pesticides in all watercourses leading from the site on the day of the fire;not unexpectedly highest concentrations were detected in streams and ditches closest to the fire site.The samples obtained in the Habitant River on the day of the fire indicated a dilution of pesticide concentrations by at least an order of magnitude directly below the culvert outfall to very trace concentrations at the aboiteau ,approximately 1.5 km downstream.Concentrations measured in the river were all less that those reported to be lethal to fish (Landau and Tucker 1984;Kulshastha and Arora 1986;Ward and Ballantine 1985;Worthing and Walker 1987) .An initial"slug" of pesticide must have passed down the river with concentrations high enough to kill large numbers of three-spined stickleback and aquatic invertebrates between Canning and the aboiteau.It must be remembered also that the pesticides analysed were not the only ones present in the firefighting water and the possible synergistic effects of these various products could be significant.Recovery from these perturbations would likely be quite rapid (Lynch _et al_.1985) due to recolonization from upstream areas.

One day after the fire the concentration of pesticides detected in the Habitant River (Table 6) were below analytical detection limits in most cases and only in very trace quantities directly below the culvert outfall from which most of the firefighting water entered the river.Pesticide concentrations remained elevated in the fire water collection trench as well as an adjacent water course,however water flow at this time was low resulting in very little input to the Habitant River.Table 7 contains results of aldicarb analyses on water samples obtained by Union Carbide staff five days after the fire.They confirm the results reported in Table 6,in that with the exception of standing water on or directly adjacent to the warehouse site,concentrations were very low.

The results of analyses for aldicarb,carbofuran, atrazine,butylate and methomyl in sediment and soil obtained one day after the fire are presented in Table 8.Samples collected near the trench,from a ditch west of Dr. Gibson's property and from the inlet to a farmers pond contained detectable amounts of these pesticides;in highest concentration were atrazine and butylate.

There were measurable quantities of atrazine in all sediments obtained from the Habitant River,however,other pesticides were at or below the detection limit of the analytical procedure.No pesticides were detected in sediment samples obtained from the Minas Basin.The lack of pesticide residues of any magnitude in Habitant River sediment cores is probably an indicator that the "slug" of contaminated water passed very rapidly with little or no sedimentation of absorbed pesticide occurring.The residues of individual pesticides in aquatic sediments were less than those which have been observed in ponds which receive drainage from irrigated croplands(kadoum and Mock 1978).Chronic effects on

TABLE 6 PESTICIDE CONTENT OF WATER SAMPLES - ONE DAY POST FIRE (June 1, 1986)

Sample #	Location	Aldicarb/ (mg/L)	Carbofuran (mg/L)	Atrazine (mg/L)
W 23	Habitant River Below Outfall	0.0004	0.013	L 0.001[1]
W 24	Habitant River 100 Metres Below Outfall	trace	trace	0.002
W 25	Trench in front of warehouse	2.0	0.24	3.6
W 26	Trench in front of warehouse (tile drain)	17.0	12.0	9.8
W 27	Brook behind warehouse	0.30	0.31	0.32
W 28	Below trench below warehouse	18.0	0.77	13.0
W 29	Inlet to Farmer's Pond	0.32	L 0.001	0.9
W 30	Above Aboiteau	L 0.001	L 0.001	0.001
W 31	Below Aboiteau	L 0.001	L 0.001	0.002
W 32	Farmers Pond Outfall	0.045	0.013	0.121

Analyses conducted by Environmental Protection Laboratory, Dartmouth, N.S.

[1] L indicates less than detection limit.

TABLE 7 ALDICARB CONTENT OF WATER SAMPLES - FIVE DAYS POST FIRE (June 5, 1986)

Sample #	Location	Aldicarb (mg/L)
W 33	Trench in front of warehouse	3.4
W 34	Standing water N.W. of warehouse	1.3
W 35	Standing water behind warehouse	4.1
W 36	Outlet from pond N.W. of warehouse	0.016
W 37	Ditch N.W. of warehouse	0.011
W 38	In pond N.W. of warehouse	0.004
W 39	Ditch N.E. of warehouse	L 0.0001[1]
W 40	Culvert at Habitant River	0.003

Analyses conducted by Union Carbide laboratories.

[1] L indicates less than detection limit.

TABLE 8 PESTICIDE CONTENT OF SEDIMENT SAMPLES - ONE DAY POST FIRE (June 1, 1986)

Sample #	Location	Type	Laboratory	Aldicarb (ug/g)	Carbofuran (ug/g)	Atrazine (ug/g)	Butylate (ug/g)	Methomyl (ug/g)
S 1	Habitant River below culvert	Core	AC[1]	L 0.1[3]	L 0.1	L 0.1	L 0.1	L 0.1
			EP[2]	L 0.05	L 0.05	0.08	-	-
S 2	Habitant River 100 metres below outfall	Core	AC	L 0.1	L 0.1	0.13	L 0.1	L 0.1
			EP	0.05(tr)	L 0.05	0.6	-	-
S 3	Ditch below trench	Core	AC[4]	L 0.1	1.5	5.2	70.0	L 0.1
			EP	0.13	0.09	2.8	-	-
S 4	Property nearest fire	Garden Soil Grab	AC	L 0.1	L 0.1	L 0.1	L 0.1	L 0.1
S 5	Property nearest fire	Garden Soil Core	AC	L 0.1	0.3 (tr)	18.0	8.6	L 0.1
			EP	0.05(tr)[5]	0.7	60.0	-	-
S 6	Drainage ditch west of Dr.'s house	Sediment Core	AC	L 0.1	L 0.1	32.0	9.0	L 0.1
			EP	L 0.05	L 0.05	1.2	-	-
S 7	Inlet to Farmer's pond	Sediment Core	AC	0.2(tr)	-	0.2	5.0	0.3(tr)
			EP	L 0.05	L 0.05	0.15	-	-
S 8	Habitant River at Aboiteau	Sediment Core	AC	L 0.1	L 0.1	0.3	L 0.1	L 0.1
S 9	Minas Basin 100 metres below Aboiteau	Sediment Core	AC	L 0.1	L 0.1	L 0.1	L 0.1	L 0.1
S 10	Property near fire	Lawn Soil Core	OC[6]	-	-	0.024	-	-
S 11	Property near fire	Lawn Soil Core	OC	-	-	0.145	-	-

---

[1] Agriculture Canada, gas chromatograph/mass spectrometer analysis, neutral basic extraction, paying particular attention to sutan, carbofuran, atrazine, chlorothalonil, captan and aldicarb.

[2] Environmental Protection, Dartmouth, N.S.

[3] L indicates less than detection limit.

[4] A major unidentified peak in this sample.

[5] tr indicates trace amounts near detection limits.

[6] OceanChem, Dartmouth, N.S. * Sample S 10 and S 11 were taken at 6" and 12" depth respectively at the same site as sample S 5 but in September, 1986.

the river community would,therefore,be unlikely.

Only methoxychlor,trifluralin,butylate and EPTC were recovered after routine clean-up of fish and shellfish analyzed by Zitko and these compounds were not detectable in any of the samples with a detection limit estimated at about 1-2 ug/g wet weight.

Zitko (personal communication)also notes that hydrocarbons characteristic of oil-based pesticide formulations and some compounds of surfactants found in emulsified concentrates were not detectable.He conludes that the absence of pesticide formulations and related compounds indicates large-scale contamination of aquatic biota has not occurred although contamination cannot be ruled out.

Four days after the fire there were no detectable concentrations of aldicarb,carbofuran or atrazine in any of the marine sediment samples or sediments at the outlet to the farmers pond west of the warehouse(Table 9).

Atrazine was found in all soil grab samples collected from properties in close proximity to the fire site.Aldicarb, carbofuran and butylate were also detected in much lower concentrations in the residential property closest to the warehouse.Both butylate and atrazine were measured in core samples from properties near the fire site(Table 10). Contamination of lawns and gardens was for the most part limited to those ares where flow of firefighting water was not confined to drainage ditches (shaded area,Figure 2).The exception to this was a site where firefighters stored equipment prior to decontaminating.

Approximately 24 hours after the fire,it was noted that earthworms had come to the surface of the soil in large numbers in drainage ditches where they died.It has been demonstrated that earthworms are sensitive to a variety of pesticides(Hague and Ebing 1983).The path the contaminated water had followed was also easily discernable approximately two weeks after the fire by evidence of damaged vegetation.Symptoms of damage were characteristic of triazine herbicides(Worthing and Walker 1987).

Residues of pesticides detected in the soils sampled were obviously enough to kill most exposed vegetation(the mix of chlorophenoxy and triazine herbicides would have provided broad spectrum activity)and they were somewhat higher than residues which have been measured in field soils where pesticides have been used.For example atrazine which was detected in concentrations as high as 272 ug/g in soil from a ditch and 60 ug/g in a lawn close to the fire site,has been measured in soils from fields treated with such products as high as 0.77 ug/g(Carery _et al_. 1979).The carbofuran and aldicarb detected in soils are very similar to concentrations in field soils measured immediately after their operational use(Gordon _et al_. 1982;Jones and Back 1984;Miles and Harris 1979).

The triazine herbicides are noted for their persistence(Ghadiri _et al_. 1984) and would likely be environmentally the most long-lived of the pesticides

TABLE 9 PESTICIDE CONTENT OF SEDIMENT SAMPLES - FOUR DAYS POST FIRE (June 4, 1986)

Sample #	Location	Type	Aldicarb	Carbofuran	Atrazine
S 13	Outlet of Pond W. of warehouse	Core	L[1] 0.04	L 0.04	L 0.04
S 14	100 m below Aboiteau mid intertidal	Core	L 0.04	L 0.04	L 0.04
S 15	100 m below Aboiteau low tide mark	Core	L 0.04	L 0.04	L 0.04
S 16	Old wharf, 1 km below Aboiteau low tide mark	Core	L 0.04	L 0.04	L 0.04
S 17	Old wharf, 1 km below Aboiteau mid intertidal	Core	L 0.04	L 0.04	L 0.04
S 18	Kingsport, mid intertidal	Core	L 0.04	L 0.04	L 0.04
S 19	Kingsport, low tide mark	Core	L 0.04	L 0.04	L 0.04

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[1] Analyses conducted by Environmental Protection Laboratory, Dartmouth, N.S.

[1] L indicates less than the detection limit.

TABLE 10 SUTAN AND ATRAZINE CONTENT OF SOIL SAMPLES - SEVEN DAYS POST FIRE (June 7, 1987)

Sample #	Location	Sample Type	Butylate (ug/g)	Atrazine (ug/g)
S 20	South side of Main Street (lawn)	Core	L[1] 0.1	L 0.1
S 21	South side of Main Street (lawn)	Core	L 0.1	L 0.1
S 22	North side of Main Street (ditch)	Core	.16	.53
S 23	North side of Main Street (ditch)	Core	182	272
S 24	North side of Main Street (lawn)	Core	19.2	1.4
S 25	South side of Main Street (lawn)	Core	L 0.1	L 0.1
S 26	South side of Main Street (lawn)	Core	L 0.1	L 0.1
S 27	North side of Main Street (lawn)	Core	L 0.1	L 0.1
S 28	North side of Main Street (garden)	Core	.2	.52
S 29	South side of Main Street (lawn)	Core	L 0.1	L 0.1
S 30	South side of Main Street (lawn)	Core	1.7	3.70
S 31	East side of property adjacent to Maple Leaf Farms road (lawn)	Core	0.79	1.88
S 32	West side of property adjacent to Maple Leaf Farms road (ditch)	Core	.1	19.5
S 33	North side of Main Street (lawn)	Core	L 0.1	L 0.1
S 34	North side of Main Street (lawn)	Core	L 0.1	L 0.1
S 35	North side of Main Street (garden)	Core	L 0.1	L 0.1
S 36	North side of Main Street (lawn)	Core	L 0.1	L 0.1
S 37	North side of Main Street (lawn)	Core	L 0.1	L 0.1
S 38	South side of Main Street (field)	Core	L 0.1	L 0.1
S 39	South side of Main Street (garden)	Core	L 0.1	L 0.1
S 40	North side of Main Street (garden)	Core	.12	.15

Analyses conducted by Agriculture Canada Laboratories, Ottawa.

[1] L indicates less than the detection limit.

released. Depending on environmental conditions such as temperature, pH, oxygen concentrations and organic content, the half-life for atrazine in soils is estimated to be in the neighbourhood of 50-100 days(Frank and Siroms 1985;Ghadiri et al. 1984).Residues of atrazine metabolites have been detected in mineral soils up to nine years after the pesticide was used operationally(Capriel et al. 1985).Soil replacement (top 6-12 inches) was undertaken at the most heavily contaminated sites;other properties would not be expected to be impacted beyond the first growing season.

No identifiable pesticide residues were detected by GC/MS screening in vegetation and soil samples collected within the smoke plume of the fire(Table 11).Using the same screening technique,atrazine was identified in vegetation which had come in contact with firefighting water.

The results of polychlorinated dibenzo dioxin(PCDD) and polychlorinated dibenzo furan(PCDF) analyses of samples taken one day after the fire,downwind from the fire,from a lawn which received an overland flow of firefighting water,and from the pool of liquid residue in the centre of the warehouse are contained in Table 12.Only a vegetation sample 500 metres downwind of the fire had detectable concentrations of these compounds.This sample consisted of a section of lawn sod immediately below the downspout of the roof to the local fire station(in the hope that the roof would act as a collecting surface for particulate matter scavenged by the rain which was falling at the time of the fire).The dioxins in this sample were hepta and octa congeners and the furans were octa cogeners.

The results of dioxin and furan analyses of samples collected seven days after the fire are contained in Table 13.Two of these were collected upwind and two downwind of the fire.Only the sample below the previously mention downspout contained measurable concentrations.

The lack of detectable parent pesticide in soils and vegetation downwind could mean that combustion of pesticides in gaseous form was complete or that there was very little atmospheric sedimentation within the sampled area .There is little doubt that the smoke plume from the fire contained a variety of organic compounds created as a result of many pesticides and their pyrolytic products being combined thermally.There is virtually no way of estimating the quantity and identity of these compounds.It is known, however, that polychlorinated dibenzo dioxins and polychlorinated dibenzo furans may be formed by low temperature combustion of chlorinated organic compounds,particularly the chlorophenoxy herbicides(Ahling et al. 1977).The sampling of vegetation and soils indicated that PCDD/PCDF was not deposited extensively downwind of the fire.

It cannot be stated with any assurance that the PCDD/PCDF residues measured at the one site originated from the fire.The fact that it was predominantly higher chlorinated congeners that were observed may indicate they resulted from long-distance transport(Czuczwa et al. 1984).

TABLE 11 PESTICIDE CONTENT OF SOIL/VEGETATION SAMPLES - ONE DAY POST FIRE (June 1, 1986)

Sample #	Location	Sample Matrix	Laboratory	Pesticide[1] Content
S 12	Field Downwind of Fire (100 m)	Soil	NRC[2] AC[4]	Nothing detected (L[3]0.01 ug/g) Nothing detected (L 0.1 ug/g)
V 1	Field Downwind of Fire (100 m)	Vegetation	NRC	Nothing detected (L 0.01 ug/g)
V 2	Lawn Downwind of Fire (500 m)	Turf	AC	Nothing detected (L 0.1 ug/g)
V 3	Orchard Downwind of Fire (150 m)	Vegetation	AC	Nothing detected (L 0.1 ug/g)
V 4	Lawn Below Warehouse	Vegetation	AC	Atrazine (30.0 ug/g)

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[1] Screened by gas chromatograph/mass spectrometer for pesticides listed in Table 2.

[2] National Research Council of Canada Laboratory.

[3] L indicates less than the detection limit.

[4] Agriculture Canada Laboratory.

TABLE 12 PCDD/PCDF CONTENT OF VEGETATION/SOIL SAMPLES COLLECTED DOWNWIND OF FIRE AND LIQUID RESIDUE FROM CENTRE OF WAREHOUSE - ONE DAY POST FIRE
(June 1, 1986)

Sample #	Location	Sample Matrix	PCDD (ng/g)						PCDF (ng/g)						% Recovery[1]
			Tetra	Penta	Hexa	Hepta	Octa	Total	Tetra	Penta	Hexa	Hepta	Octa	Total	
V 5	500 metres downwind of warehouse (Fire Department)	Turf (vegetation and soil)	L[2]0.001	L 0.001	L 0.001	0.2	0.7	0.9	L 0.001	L 0.001	L 0.001	L 0.001	0.03	0.03	95
V 6	100 metres downwind of warehouse (orchard)	Vegetation	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001		103
V 7	Lawn below warehouse	Vegetation	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001		97
C 1	Centre of warehouse	Liquid Residue	L 0.01	L 0.01	L 0.01	L 0.01	L 0.01	L 0.01	L 0.01	L 0.01	L 0.01	L 0.01	L 0.01		125

Analysis conducted by Environmental Protection Laboratories, Ottawa.

[1] % recovery of d12-triphenylene.

[2] L indicates less than detection limit.
(L 0.001 is approximate)

TABLE 13 PCDD/PCDF CONTENT OF VEGETATION SAMPLES - SEVEN DAYS POST FIRE (June 7, 1986)

Sample #	Location	Sample Matrix	PCDD (ng/g)						PCDF (ng/g)						%
			Tetra	Penta	Hexa	Hepta	Octa	Total	Tetra	Penta	Hexa	Hepta	Octa	Total	Recovery[1]
V 8	500 metres downwind of warehouse (Fire Department)	Vegetation	L[2]0.001	L 0.001	L 0.001	0.1	0.6	0.7	L 0.001	L 0.001	L 0.001	L 0.001	0.03	0.03	118
V 9	Water Reservoir	Vegetation	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	110
V 10	West Cornwallis	Vegetation	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001	93
V 11	Pereau Road	Vegetation	L 0.02	L 0.02	L 0.02	L 0.02	L 0.02	L 0.02	L 0.02	L 0.02	L 0.02	L 0.02	L 0.02	L 0.02	105

Analysis conducted by Environmental Protection Service laboratories, Ottawa.

[1] % recovery of d12-triphenylene.

[2] L indicates less than detection limit.
(L 0.001 is approximate)

It is difficult to assess the significance of these residues since there has been very little monitoring conducted in Canadian environments.The concentrations are similar to those found in lake sediments remote from industrial sources (Czuczua et al. 1984).

Drinking water samples collected by the Nova Scotia Department of Health for several weeks after the fire showed no traces of pesticides(personal communication - Dr.J.Prentiss).In the samples collected by the Water Quality Branch of Environment Canada on June 5 and September 24,1986 only two contaminants were observed (personal communication - Mr.H.O'Neill).Lindane was noted in one sample at a level of 0.01 ug/l and fluoranthene was recorded at a level of 0.002 and 0.004 ug/l in the spring sampling.Both substances are ubiquitous and have been observed in other Atlantic Region municipal water supplies.

No aldicarb,carbofuran,atrazine or PCDD/PCDF residues were detected in milk samples collected from a farm located 1.5 km downwind of the fire (Table 14).

TREATMENT OF CONTAMINATED WATER AND DEBRIS

Manufacturers /suppliers with pesticides present in the Maple Leaf Farm Supplies Limited warehouse at the time of the fire (Chipman Chemicals,Union Carbide,Dupont Chemicals, Velsicol Canada,BASF,Ciba-Geigi and Hoechst Canada Inc.) responded rapidly to requests for detailed information on the toxicity,appropriate containment,neutralization and clean-up of their products;they also sent representatives on site to remove identifiable pesticide products for reprocessing and disposal.Two cylinders of the fumigant methyl bromide were recovered intact from the site by the supplier.Union Carbide recovered and shipped 13 drums of waste Temik from Canning on June 4,1986.

Following this stage of the clean-up a hazardous waste contractor,Sanexen International,was retained to undertake the warehouse site clean-up.The company deployed a 40 ft tractor trailer as an operations centre for the clean-up Work crews were outfitted with protective clothing to shield them from pesticide residues as well as from caustic cleaning solutions.

The warehouse structure was dismantled and the building materials along with other large pieces of debris were decontaminated with a fine spray of detergent and weak caustic solution and temporarily stored in a limed and bermed area adjacent the fire site.The company segregated contaminated from uncontaminated debris;all large uncontaminated and decontaminated building materials were disposed of in a local landfill.The location of all items deposited at the landfill site were mapped for future reference.

TABLE 14 PESTICIDE PCDD/PCDF CONTENT IN MILK - TWO DAYS POST FIRE (June 2, 1986)

Sample #	Sample Type	Location	Units	Aldicarb/ Sulfone	Carbofuran	Atrazine	PCDD/PCDF
M 1[1]	Milk	1.5 km southeast of warehouse	ug/g	L 0.04[2]	L 0.04	L 0.04	
M 2[3] southeast	Milk	1.5 km southeast of warehouse	ug/g	-	-	-	L 0.000001[4]

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[1] Analyses conducted by Environmental Protection Laboratory, Dartmouth, N.S.

[2] L indicates less than the detection limit.

[3] Analyses conducted by National Health and Welfare Laboratory.

[2] This value indicates that there were no detectable levels of polychlorinated dibenzo-p-dioxins/furans at the 1 ppt level. All homologous groups up to the octa congeners were included.

Broken containers of chemicals and loose chemicals were shovelled into labelled steel drums and sealed.The liquid remaining was contained and either vacuumed into drums or treated with soda ash and soaked up using absorbent clays.This material was also drummed and labelled.

Although clean-up crews were able to finally leave Canning one month after the fire it was almost a year later, in March 1987,that the remaining waste on site (50 drums of manzate waste,20 drums of waste from the reverse osmosis unit,111 drums of waste from the clean-up by Sanexen)was shipped to Ontario for treatment and disposal at an approved secure chemical landfill site.This delay resulted from a shortage of space at the selected disposal site and the need for the company to obtain approval for,and then develop this new storage capacity.

Roughly 100,000 l of contaminated run-off water and waste water generated during site clean-up collected in a trench dug down slope from the warehouse.This water was periodically pumped into a tanker truck to allow settling of particulates and await treatment and disposal.Removal of water from the trench also aided decontamination and dewatering of the fire site.A reverse osmosis unit(mobile filtering system) belonging to Environment Canada was employed to process the waste water.The unit consists of a feed pump,two 5-25 um pre-filters,a high pressure pump and pressure vessels containing reverse osmosis membranes(R.Dutton,1986).The R.O. was on scene from June 10 to June 29,1986.In combination with activated carbon filters the unit effectively removed 99 percent of the pesticide residues(Whitacker _et.al_.1988).Levels in the water were reduced to below background levels prior to discharge to the Habitant River.Alum was used to enhance suspended solids removal(approximately 400 ppm was optimal) prior to filtering.This flocculation step also tended to significantly reduce the concentration of some pesticides in the supernatant solution prior to further processing;for example atrazine levels declined from 9000 ppb to 200 ppb (R.Dutton,1986).

The original volume of waste water noted above was reduced to roughly 4000 l of sludge and concentrate and 400 l of spent carbon.All of this material was drummed and disposed of with other contaminants out of province.

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HYDROFLUORIC ACID RELEASE AT MARATHON PETROLEUM COMPANY

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The Marathon Petroleum Company is a 166 acre oil refining facility located within the southern city limits of Texas City, Texas, a community with a population of approximately 40,000 inhabitants. The area immediately surrounding the plant is a mixture of residential and heavy industrial development, primarily petro-chemical refineries.

The hydrofluoric acid (HF) alkylation process within the Marathon Petroleum Company uses hydrofluoric acid as a catalyst to convert olefins to alkylates.

The HF alkylation process is shut down every 3-4 years for preventive and remedial maintenance.

The Incident

At 5:20 p.m. on Friday, October 30, 1987, a crane was moving a convection section of a heater from a vertical heating vessel to a semi-trailer truck. This action was being taken as part of the maintenance program of the HF alkylation unit. As the section of the heater was being moved above the HF vessel, it was dropped shearing off a 4 inch acid loading line and a 2 inch pressure relief line from the top of the HF vessel. The oval shaped HF vessel was 43 feet 2 inches in height with a diameter of 16 feet 6 inches. The capacity of the vessel was 60,000 gallons at 125 pounds per square inch of pressure. At the time of the incident, the vessel contained a mixture of approximately 289,170 pounds (35,700 gallons) anhydrous hydrofluoric acid (HF), acid soluble oil and water and isobutane. When the pipes were sheared off the tank, the hydrogen fluoride and isobutane were released as a vapor. HF is a colorless liquid or vapor with a specific gravity of 0.987 and in the vapor state is heavier than air. The boiling point is 67 degrees Fahrenheit (67°F). The ambient air temperature during the entire release period was consistently above 67°F. Because the HF was under pressure and the release occurred approximately 43 feet above ground level, the release of the HF acid vapor was upward increasing the mixing and dispersion of the plume within the ambient air. The resulting HF acid vapor plume traveled to the northwest with a prevailing wind of 8-12 miles per hour, crossing a portion of the Marathon facility and then into the neighboring residential area.

The Response

Immediately after the incident occurred, Marathon initiated its onsite and offsite alert and notification systems as well as measures to mitigate the release. The in-plant emergency warning system was activated and notification to the Industrial Mutual Aid System (IMAS) was made. The notification to the IMAS included: a request for all available fire fighting equipment in the area; that all hospitals be put on emergency alert; and that the residential areas downwind of the release be evacuated. Following the call to the IMAS, Marathon notified the Texas City Emergency Operations Center of the release and recommended evacuating specified areas downwind of the release. Marathon also provided notification to the National Response Center (NRC) in Washington, D.C., the U.S. Environmental Protection Agency (EPA) Region 6 office in Dallas, Texas, the U.S. Coast Guard, the Texas Air Control Board (TACB), the Texas Water Commission (TWC), and the Galveston County Health District. (The Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and the Superfund Amendments and Reauthorization Act (SARA) provide for civil and criminal penalties for failure to report immediately the release of a designated hazardous substance when the release exceeds the reportable quantity (RQ) for that substance. The RQ for hydrofluoric acid is 100 pounds). All of these federal, state, and local governmental agencies provided response personnel during the course of the incident. In addition, response personnel and resources were provided by DuPont, Amoco Oil, Amoco Chemicals, GAF Corporation, Monsanto Chemicals, Sterling Chemicals, Texas City Refining, Union Carbide, and the Red Cross and Salvation Army. Marathon committed the resources, personnel and equipment, of its refinery in addition to support from its corporate office in Findley, Ohio. The City of Texas City committed the resources of its fire, police, and public works departments while the State and surrounding communities provided additional law enforcement personnel, fire personnel and fire fighting equipment for backup support.

To mitigate the release, Marathon emergency response personnel sprayed a water curtain across the plume to absorb as much of the HF as possible and to minimize the amount that could disperse into the atmosphere. This action was initiated approximately 15 minutes after the release began. Marathon estimates that most of the HF was released during the first two hours of the incident and only minimal amounts until the tank was plugged. Most of the water from the spray was routed to the facility's water treatment plant. Standing water, runoff water in the drainage ditches, and water inside the tank firewall was treated with lime and caustic soda and then released. This method of water treatment was approved by the Texas Water Commission. The second step taken was to develop a plan for off-loading the tank. The first plan was to off-load the tank into vacuum trucks. However, due to the large volume to be off-loaded and the need to disengage the discharge lines if trucks were used, the decision was made to off-load the tank contents into railroad tank cars instead. The tank cars were delivered from Houston, Texas and arrived at the plant site at 8:30 a.m. on Saturday, October 31. Off-loading of the tank began at 1:30 p.m. and continued until 4:00 a.m. Sunday, November 1, when the head pressure in the tank became insufficient to keep the pump primed. Because there was concern over the structural integrity of the tank, it had been decided that no attempts would be made to plug and repressurize the HF tank. It had also been decided that a larger pump for off-loading would not be used because its installation would require disengaging the discharge lines and therefore, would increase the potential for accidental releases of HF. However, when it was no longer possible to keep the discharge pump primed, the tank was inspected and determined that no apparent damage occurred to the lower sections. It was then decided to plug the severed lines at the top of the tank and then pressurize the tank to 5-10 psi. The first plugs used were of the expandable rubber and steel type. These proved to be unsatisfactory as the jagged steel on the tank punctured the plug allowing a leak. These plugs were then replaced with wooden plugs which were successful in sealing the tank. Pumping was then resumed and the tank was emptied by 9:40 p.m. on Sunday, November 1.

Marathon and state, local, and federal governmental agencies conducted various types of monitoring and sampling during the time the release was occurring. Air, water, and soil samples were collected and analyzed for residual acidity and for elevated fluoride levels. Wipe samples were collected from cars, homes, etc. No significant levels were detected. As a precaution, the residents were advised to wash all exposed surface areas such as dishes, clothes, etc., and dispose of any food that may have been exposed to the acid plume when they returned home.

Although there were no fatalities from the incident, approximately 550 people were examined at area hospitals, 52 were admitted, and 20 were required to stay more than 24 hours. To assist local physicians, Marathon solicited the assistance of Dr. Michael Trevino, a physician with DuPont Chemicals in Mexico and considered as an expert by the World Health Organization relative to the health effects from the exposure to hydrofluoric acid. Dr. Trevino conducted a seminar on the effects of hydrofluoric acid for medical personnel at one hospital. The seminar was videotaped for medical personnel at other hospitals.

Marathon has various process controls, monitoring, safety programs, etc., to prevent accidental chemical releases and to be prepared if such a release should occur. The accident causing the hydrofluoric acid release was a construction accident and not an upset in the process itself.

To alert employees when a release occurs, steam whistles are located at various points around the refinery. Telephones are also located throughout the plant for emergency notification and all operators carry radios at all times. Emergency command posts can be established at several areas around the refinery. If for whatever reason, none of these pre-designated areas could be utilized, Marathon could obtain a mobile command post through their affiliation with IMAS.

To insure coordination with the public, Marathon is a member of the Chemical Manufacturer's Association, the Community Awareness and Emergency Response (CAER) program, the Texas City-LaMarque Local Emergency Planning Committee (LEPC), and the IMAS. Through the CAER program, Marathon has participated in the installation of warning sirens throughout the residential areas to warn residents of any potential chemical emergency. Also, through the CAER program, pamphlets have been prepared and distributed to residents explaining the purpose of the warning system and evacuation procedures. IMAS, established in 1949, is a 19-member emergency alert and response cooperative composed of industry and local government representatives. Through the IMAS radio network, members can alert or request assistance from other members during an emergency incident.

Summary

In retrospect, the on-site and off-site response to the hydrofluoric acid release was successfully carried out. However, there are several areas relative to the incident that are worthy of review: (1) The location of the crane relative to the truck, required the crane to lift the convection heater unit over the HF acid vessel. If this was the only possible location for the crane and the truck consideration should have been given to temporarily emptying the HF acid vessel until the construction work was completed; (2) The CAER warning system (sirens) had been in place for only four months prior to the incident. However, had measures been taken to more fully inform the public as to the meaning of the sirens and the appropriate actions to take when the sirens were sounded, it is possible that the evacuation could have been completed more rapidly and with less involvement by local police; (3) The initial evacuation of the residents was to the Nessler Center which was later determined to be in the downwind path of the plume. As a result, the residents were again relocated, this time to the Northside School. Had the capability existed to conduct air dispersion modeling, local response personnel would have had more accurate information on which to base their evacuation decision.

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Dangerous Goods and The Edmonton Tornado
Planning for Disasters

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On July 31, 1987, nature delivered a devastating series of blows to the residents and industries on the east side of Edmonton, Alberta. After a prolonged period of extremely warm temperatures, a storm system moved into the area. As a result of a number of weather pattern factors, a massive tornado formed south east of the City. Tornado touchdowns were first reported in the Leduc-Ellerslie areas, mostly in farming areas outside the City. The tornado tracked in a north-north east direction, skirting the Millwoods suburb before moving into the southeast light industrial area of Edmonton. This area, as well as and the Knightbridge and Sherwood Industrial Parks in the County of Strathcona, suffered severe damage. The tornado then moved across the North Saskatchewan River to deal final blows to the suburb of Clareview and the Evergreen Trailer Park. Damage to the residential areas has been the focus of a number of reviews. The total damage estimate is fast approaching $500,000,000.00.

Emergency response by the City of Edmonton and the County of Strathcona has been subjected to a number of indepth reviews. This paper will attempt to review some of the major dangerous goods identification issues, cleanup considerations, and aspects of industrial disaster planning in light of the lessons learned from this major emergency. These aspects of the disaster barely hit the headlines, but resulted in a significant response by the City of Edmonton, the County authorities and the Provincial Government.

Virtually dozens of industrial sites were damaged and most had dangerous goods on the premises. A wide range of hazardous materials and waste was documented including compressed gases, corrosives, transformers, hydrocarbons, and pesticides. Even radioactive sources were identified. The process of identifying the materials and ensuring safety created a significant problem for the search and rescue teams. Heavy rainfall, combined with materials spread during and after the destruction of the industrial area, created a large area of "potential contamination" which stretched the resources of Alberta Environment's PERT (Pollution Emergency Response Team) organization.

After the response and cleanup processes were complete, a number of critical issues which should be addressed when developing a site emergency plan were identified. Many of these were identified during the incident analyses conducted by Alberta Public Safety Services and Alberta Environment.

CONTACT PERSONNEL & RESOURCES

* Does the plan include details of the types, locations, and quantities of dangerous goods on site?

The ideal site emergency plan should include, in some detail, the types, hazards, locations and normal quantities of all goods stored or used on the site. Since a major incident can disrupt the normal order of the process or storage, it is essential that company representatives work with emergency response personnel on what were previously non dangerous goods but are now damaged or have been contaminated.

In this incident, sites were contaminated with dangerous goods from other locations, and in many instances company personnel were called upon to resolve problems at neighbouring sites (The rate of resolution of these types of problems was often hampered due to lack of knowledgeable site personnel). This resulted in response forces using inventory data and on-site surveys of companies in the damaged area to develop a total area inventory and determine appropriate disposal methods for many of the contaminated materials.

* Does the plan include details of contact personnel, and resources that are not site dependent? How can the local emergency forces get this data from an off-site source? Does the plan deal with the interface between the company and the local authorities? Has the plan been discussed with the local response forces?

When developing a plan, company personnel assigned to work with the emergency forces in the community should set up a system to store names of contact personnel and other essential data off-site. Discussions with the local emergency response forces (including fire departments, police, ambulance and rescue personnel) are essential in terms of response to any incident on site. In the Edmonton area much of this liaison and communication had been initiated by the "Edmonton Emergency Planning Committee". This committee is chaired by the City of Edmonton Disaster Services Officer and is made up of City department representatives, surrounding municipal reps, industrial reps, and people from the provincial government. The emergency response specialist in your community can provide very useful input from an outsider's view of the site plan. Contacts with the local authorities are essential to ensure that all groups work in unison.

* Are there sufficient resources available for recovery and cleanup operations? For large scale disasters the local resources may well be stretched to the limit.

The plan should examine what recovery equipment and personnel are available both from the company and through arrangement with local contractors. Contractual arrangements and if necessary, pretraining of contractor personnel must be completed. Ensure that the same contractor is not under a similar commitment to other sites in the area. If so, determine their capacity to cope with large scale situations. Backup arrangements may be necessary.

- Does the plan deal with the personal safety aspects of employees, response personnel and contractors brought in at later stages of cleanup and recovery.

During the cleanup and recovery phases, a large number of contractors may well be brought on to the site for cleanup, debris removal, structure demolition, waste containment and removal and reconstruction. The plan must ensure personal safety training and familiarization as well as sufficient operable safety equipment.

In many cases, local response forces will not be equipped to deal with speciality chemicals and may need special equipment. Emergency 24 hour contacts for personal safety equipment must be listed in the plan. The training of the various response forces will vary in terms of their primary roles and gaps may need to be filled.

RESPONSIBILITIES AND RECOVERY PHASES

- Does the plan detail responsibilities and action for all aspects of the emergency response and recovery phases?

The tornado in the Edmonton and Strathcona areas affected a wide area and a large and diverse group of emergency responders were involved. Often the location and how the municipal emergency plan was structured determined how response was carried out. Site security and access were addressed differently by the Edmonton Police Department than by the Royal Canadian Mounted Police (RCMP) in the County of Strathcona. The approach varied on the basis of the local emergency plan, the site conditions and the area affected (residential as opposed to industrial). In Strathcona, the RCMP closed down the industrial sites for the full period of the search and rescue until the whole area had been cleared, whereas the Edmonton City Police opened up parts of the industrial areas to the companies as the search and rescue teams completed their work in the particular section. Both approaches are valid given the diverse nature of the businesses in the area.

Where the site is sealed off, the function of a company may well be one of liaison with the site commander. Alternatively, there is a need in some cases for the company to work very closely with search and rescue and other specialty teams.

Companies should ensure that their own site plans take into account the municipal emergency plans, and that personnel tasked with implementation of the site plan are familiar with the details of the local authority's approach to emergency response. If this is done at the drafting stage, the company can ensure that personnel are fully familiar with the roles of the various response agencies in the community, and the opportunity for integrating the company plan with the local authority emergency plan will ensure a clear understanding of the roles and responsibilities of all concerned.

SITE SERVICES AND COMMUNICATIONS

In an incident of the scale of the Edmonton tornado, services to the area are affected for a considerable length of time. Companies should review their plans to ensure that they can begin the recovery phase with a minimum of services (power, water, natural gas, telephone).

* How much of the company data relies on on-site computers, and how will the company be able to access this data?

Many sites are moving to the point where much of their data is stored on a computer, with very little in the way of paper records. In a disaster the size of the Edmonton tornado, both computer and paper records were destroyed or unavailable for a considerable period of time. Trucking companies in the affected areas were, in some cases, not able to check on what was in the vehicles in their depots at the time of the tornado. This kind of data was needed by the response teams to initiate the necessary steps, and to ensure safe conditions for the response crews, and to prevent environmental contamination.

The company's plan should review records management and recovery of records, and how such records can be retained off site for quick recovery and reference. While on-line data may be ideal for normal day-to-day operation of the plant site, how can important data be accessed from a remote site if power to the site is out, and the site itself inaccessible? Are there backup systems in place? Such as another computer based system or frequently updated hardcopy records, kept off site.

* How will the company deal with the large scale environmental contamination that results from a major disaster? What can/will the company do to deal with the large volumes of waste generated by such an incident?

The Edmonton tornado resulted in contamination of some areas with structural debris and equipment, as well as dangerous goods. Structural debris was significant at existing facilities, but there was also a large amount of contaminated soil, equipment and product. Before reconstruction and recovery phases could be undertaken, these wastes had to be contained, removed and disposed of at acceptable treatment facilities. Some of this was recycled, but a significant quantity was sent to the Special Waste Treatment Facility at Swan Hills, Alberta. The site plan should consider what could arise in the way of hazardous waste, approximate quantities, equipment needed for cleanup and containment, and what can be done to prepare for a major disposal problem.

The time and effort spent in planning, and especially disaster simulation exercises, will reap many benefits even if an event of the scale of the Edmonton tornado does not occur. By having a plan in place, a company's response to all incidents will have a rational and tested basis during any incident, large or small.

INTERVENTION DES GOUVERNEMENTS À ST-BASILE-LE-GRAND, QUÉ.

ANDRÉ TREMBLAY
PROTECTION CIVILE CANADA

INTRODUCTION

Le 23 août 1988, à 20h40, un incendie s'est déclaré à St-Basile-le-Grand dans un entrepôt qui contenait approximativement 3000 barils de BPC et de produits divers contaminés aux BPC. Cette municipalité de 9000 habitants est située à 35 kilomètres au sud est de Montréal.

Dans les minutes qui ont suivi s'est déclenchée la plus importante opération d'urgence que la rive sud de Montréal n'ait jamais connue. Les pompiers de la ville connaissaient bien cet entrepôt et son contenu. Au début, on a tout essayé pour éteindre le brasier et il faut rendre hommage au courage et à la tenacité des pompiers de St-Basile et des municipalités environnantes qui tentèrent de maîtriser l'incendie avec des équipements conventionnels (lances à incendie, canons à eau) alors que les murs métalliques de l'entrepôt empêchaient l'eau d'atteindre le foyer principal d'incendie. La chaleur dégagée par l'incendie était trop forte pour permettre à quiconque de s'approcher et de pratiquer une brèche importante dans le toit ou les murs de l'entrepôt. Cette brèche, elle sera créée par des explosions qui ouvrent le toit. Par la suite, le travail des lances à incendie et des canons à eau permet de refroidir suffisamment le brasier pour favoriser l'entrée en action des pompiers de la Défense nationale, de la base des Forces canadiennes de Saint-Hubert. Ces derniers réussissent à étouffer les flammes en utilisant 25,000 litres de mousse anti-incendie. Vers 03h00 le 24, le feu est enfin considéré comme éteint grâce à l'effort combiné des intervenants.

Pendant cette période de plus de 6 heures, on a mobilisé les ressources des corps de pompiers de Beloeil et de St-Bruno, en plus de ceux de St-Basile-le-Grand. Les policiers municipaux, assistés de la Sûreté du Québec ont établi des barrages de contrôle au site et exécuté l'évacuation de plus de 3,800 résidents de St-Basile-le-Grand, de St-Bruno-de-Montarville et de Ste-Julie. Les lieux ont été évacués suivant un plan élaboré avec l'aide du service d'environnement atmosphérique d'Environnement Canada qui a produit le modèle de circulation et de dispersion du nuage toxique, et sur la recommandation du Docteur Carrier, toxicologue, qui avait déjà évalué les effets d'un feu de BPC en d'autres occasions. Des écoles furent ouvertes afin de permettre l'hébergement des évacués qui désiraient s'en prévaloir. Les autres se sont relocalisés chez des parents, des amis, ou à l'hôtel.

Les experts d'Environnement Canada, conservation et protection, se sont rendus sur les lieux dans les premiers moments et convinrent immédiatement, avec Environnement Québec, la Sûreté du Québec et la Municipalité de StBasile-le-Grand, de l'importance du désastre et entreprirent la préparation et l'exécution d'un programme d'échantillonnage. Au matin, les laboratoires disponibles pour ce genre de test étaient mobilisés et les premiers échantillons se mettaient en route. Le laboratoire de campagne d'Environnement Canada s'était aussi déployé pendant la nuit et démarrait l'analyse d'un groupe d'échantillons afin de proposer aux gestionnaires de l'évènement une image préliminaire de la situation.

Ces résultats furent très utiles dans les premières journées afin de redéfinir la zone d'évacuation et de proposer les plans d'échantillonnage subséquents. Près de 1200 autres résidents dûrent ainsi être évacués dans les 5 jours suivants.

LES BPC

Les biphényles polychlorés ont été synthétisés en laboratoire pour la première fois en 1881. Vers 1930, ils sont introduits dans le monde industriel où ils obtiennent un succès immédiat grâce à leurs qualités remarquables. Stabilité chimique, résistant à la combustion, super isolant électrique et grande capacité d'échange de chaleur. Les BPC ne sont pas aussi toxiques que le disent souvent les média. L'homme tolère très bien les BPC. Leur principal danger est leur longévité. Peu dégradables, ils s'accumulent dans l'environnement, se fixent dans les tissus gras des êtres vivants, poissons et mammifères, et se transmettent même dans le lait maternel aux nourissons. On pense qu'ils sont susceptibles, à haute concentration, de causer des malformations congénitales et des problèmes de croissance. La science n'a pas encore terminé d'étudier tous ses effets chez l'homme et dans l'environnement. Les gouvernements Nord-américains ont décidé en 1977 d'en interdire la fabrication et d'en restreindre l'usage. Les stocks s'accumulent donc dans des entrepôts en attendant le développement d'un moyen sûr d'en disposer, car si on les incinèrent à moins de 1500°C, il peut en résulter la production de sous-produits des familles Dioxines et Furannes dont certains membres sont extrêmement toxiques.

ÉCHANTILLONNAGE

Afin de caractériser les zones et les niveaux de contamination aux BPC de même qu'aux sous-produits de combustion, un programme d'échantillonnage de l'air, de l'eau, du sol, des végétaux, des animaux et des humains a été entrepris aussitôt l'équipement disponible.

Air

Une première station de mesure de contaminants dans l'air est installée près du site du feu vers 05h00 le 24. Jusqu'à 6 stations seront misent en action dans les jours qui suivent. Une unité TAGA-3000 est obtenue du Ministère de l'Environnement de l'Ontario et une unité TAGA-6000 du New York State Department of Environment Conservation. Ces unités vérifieront la qualité de l'air dans les résidences et les édifices publics.

Eau

L'eau déversée sur le site de même que l'eau de pluie sont retenues grâce à un système de fossé et de bassin que l'on construira avant même que le feu ne soit complètement éteint. Cette eau sera décontaminée avant d'être rejetée dans un ruisseau adjacent. On prélève aussi de nombreux échantillons des lacs et cours d'eau situés sous le passage du panache de fumée.

Sol

Des échantillons sont prélevés selon un plan qui couvre 5 zones reparties à diverses distances du site du feu. Ceux-ci se composent de

Frottis intérieurs et extérieurs et d'échantillons de surface du sol. Plus de 500 unités d'échantillons seront prélevés et distribués dans 11 laboratoires canadiens et américains afin d'en mesurer les quantités de polluants. Comme les tests quantitatifs pour Dioxines et Furannes prennent de 3 à 5 jours, on comprend que des délais importants seront alors imposés aux gestionnaires de l'évènement avant qu'ils n'aient suffisamment d'information pour annuler l'ordre d'évacuation.

Animaux et végétaux

472 échantillons de lait, de sang, de produits comestibles et de sol ont été recueillis et analysés. Un embargo a été placé initialement sur la commercialisation des produits de 4700 acres de terre. Après évaluation des tests cet embargo sera ramené à 3500 acres. Tous les produits de culture seront détruits. Les animaux n'ont pas été contaminés car dès les premiers jours, il a été recommandé aux élevers de rentrer les animaux à l'étable et de les nourrir avec des denrées déjà en grange.

Humains

Des prélèvements de sang ont été effectués sur tous les humains qui de près ou de loin auraient pu être contaminés. Les pompiers, policiers, autres travailaleurs d'urgence et citoyens évacués ont tous été testés. Plus de 5600 échantillons ont été analysés. Un suivi spécial se continue pour les mères qui allaitent et pour quelques cas positifs aux premiers tests enzymatiques du foie.

FONCTIONS D'URGENCE

Municipales:

Dans la grande majorité des sinistres qui nous frappent avec peu d'avertissement tel celui qui nous intéresse ici, les ressources municipales sont les premières à réagir et ici encore, la tradition s'est répétée. Les policiers ont reçu l'appel, se sont rendus sur les lieux et ont de là mobilisé les pompiers, les travaux publics, l'administration, la Sûreté du Québec. Ces personnes ainsi que les autres qui ont reçu le message d'autres sources, telle la radio, ont dû prendre des décisions de très grande importance pour combattre l'incendie, contrôler l'accès, évaluer l'importance de la menace, évacuer les environs, informer les autorités, recevoir et satisfaire les média. Ils ont dû prendre les centaines de décisions nécessaires à la poursuite des opérations, répondre aux demandes des citoyens, penser à quoi faire dans la prochaine minute et oublier pourquoi on n'a pas fait autre chose dans la dernière. Pendant la période de l'impact et les premiers moments de la réaction, il est tout à fait normal de se sentir débordé. Effectivement, l'aide finit par arriver et les efforts des premiers moments portent des fruits. Généralement, la situation se stabilise lorsque l'assistance extérieure s'engage dans le combat.

Provinciales:

Au Québec, les organismes du gouvernement peuvent agir à la demande d'une municipalité ou directement s'il est jugé que le genre de sinistre tombe sous sa juridiction et que l'importance de l'événement justifie le déploiement des ressources. On retrouvera donc sur le site les ressources humaines et physiques de la Sûreté du Québec qui assiste les policiers des 3 municipalités à contrôler les accès à la zone évacuée. Le Ministère de l'Environnement pour la coordination et l'exécution de l'échantillonnage, de leur interprétation après analyse. Le Ministère de l'Agriculture pour l'évaluation de la menace envers les animaux et les cultures sous le passage du nuage toxique. Le Ministère de la Santé et des Services sociaux pour l'évaluation des effets toxiques sur la santé des citoyens évacués, sur les pompiers, policiers et autres premiers répondants, et pour l'assistance physique et morale aux personnes évacuées. Le Bureau de la Protection civile du Québec pour la coordination des ressources matérielles et financières et pour la gestion des centres de service et d'information publique. Enfin, le Ministère du Loisir, Chasse et Pêche pour l'échantillonnage et l'évaluation des effets sur la flore et la faune sauvage dans le territoire évacué.

La coordination et la direction de toutes ces ressources est assuré par les ministres de chacun des ministères impliqués et par un délégué du Premier Ministre. Les décisions relatives au bien-être des citoyens et la protection de l'environnement sont donc prisent au plus haut échelon provincial.

Fédérales:

On retrouve aussi sur le site nombre d'intervenants fédéraux qui sont venus assister et compléter les ressources des municipalités et de la province, en fournissant les équipements et spécialistes sous leur contrôle. Ces personnes se sont mobilisées à la demande, soit d'organismes provinciaux, soit de Protection civile Canada, ou directement lorsqu'il était dans leur mandat d'offrir les services à la population. On retrouve sur le site, Environnement Canada pour la collecte d'échantillons, leur analyse locale et en laboratoire, de même qu'à titre de conseillers spécialistes. Défense Nationale pour le support logistique, pour un camion pompier à mousse et pour le transport rapide d'échantillons vers les laboratoires extérieurs. Agriculture Canada pour assister Agriculture Québec dans la prise et l'analyse d'échantillons d'animaux et végétaux. Communications Canada pour la provision [illegible] moyens supplémentaires de communications tels: téléphones, téléphones cellulaires, radio VHF et autres. Emploi et Immigration Canada pour l'assistance aux personnes et commerces qui n'ont pu opérer pendant la période d'évacuation et, conjointement avec Revenu Canada, Douanes et Accise, pour faciliter la venue au Canada des experts et équipement en les exemptant des lois de l'immigration et de l'importation. Protection Civile Canada pour la liaison entre les organismes fédéraux et les autres intervenants. De plus, le député fédéral du comté a été délégué à titre de représentant officiel du Premier Ministre du Canada pour maintenir le contact et assurer le suivi au plus haut niveau.

INTERPRÉTATION DES ANALYSES

A mesure que les résultats d'analyse étaient retournés par les laboratoires, les experts des organismes procédaient à la corrélation des contaminants envers la santé des humains et des animaux et à la détermination de l'impact environnemental. A la demande des ministres responsables, un comité d'experts internationaux fut invité à réviser le processus d'évaluation pour le corroborer. Les résultats d'analyse ont permis d'itentifier trois zones:

a) le site de l'incendie qui est fortement contaminé.

b) une zone au nord du site située sous le panache et qui nécessitera une décontamination mineure.

c) le reste de la zone évacuée qui ne présente pas de contamination significative. Par exemple, les BPC et les Furannes au sol sont jusqu'à 15000 fois sous le critère de qualité reconnu.

Les experts ont ensuite conjointement formulé les recommandations suivantes:

1. Les populations concernées peuvent dès le 9 septembre réintégrer les zones écacuées, sans danger pour leur santé.

2. Par prudence, les mesures de décontamination suivantes devraient être prises dans les zones résidentielles:

a) nettoyage méticuleux des prises d'air des appareils de climatisation ou de ventilation qui fonctionnaient au moment de l'incident ou qui ont fonctionné pendant la prédiode d'évacuation;

b) Dans les limites de la zone évacuée, lavage des surfaces extérieures et de toutes les surfaces potentiellement exposées aux fumées et aux suies de l'incendie, nettoyage des maisons, des véhicules, des patios et des autres surfaces dures, en particulier celles qui ne sont pas exposées à la pluie;

c) Recommandation de ne pas utiliser, à des fins d'alimentation humaine ou animale, les récoltes de légumes, les fruits et les baies provenant de la zone contaminée.

3. Un programme de surveillance environnementale devrait être mis en oeuvre.

4. Un programme de suivi épidémiologique et médical de l'ensemble de la population de la zone évacuée devrait être entrepris; ce programme devrait permettre de dépister une intoxication aigue ou chronique, d'éventuels effets cliniques et, le cas échéant, des séquelles psychologiques.

5. Un programme de suivi des effets pathologiques subaigus et chroniques chez les personnes fortement exposées (groupes d'intervention et autres) devraient être mis en oeuvre.

6. Un programme spécial de suivi vétérinaire des animaux se trouvant dans la zone contaminée devrait être entrepris.

7. Des mesures devraient être prises pour améliorer la préparation des groupes d'intervention dans les cas d'accidents chimiques, notamment en ce qui concerne la coordination des mesures d'urgence. Ces plans d'intervention devraient préciser les responsabilités des différents individus et organismes concernés, et définir clairement l'instance chargée de la planification et de la mise en oeuvre des mesures requises.

8. Les plans d'intervention devraient également prévoir le partage des tâches et des responsabilités de coordination, ainsi que des mécanismes permettant aux laboratoires d'analyse d'augmenter soudainement leur capacité de traitement des échantillons. Un système interne et inter-laboratoires de contrôle de la qualité devrait être élaboré.

9. Il faut procéder à la décontamination du foyer d'incendie, de même qu'au transport et à l'élimination adéquats des déchets contaminés, en accordant une attention particulière à la santé et à la sécurité des équipes

responsables de la réhabilitation du site.

10. Ce Groupe ad hoc d'experts internationaux devrait procéder à une nouvelle évaluation de l'incident dans les six mois.

Le gouvernement du Québec a immédiatement entrepris de remplir toutes ces recommandations et a instauré dans les ministères responsables des programmes de suivi concernant l'eau de surface et souterraine, l'air ambiant, le sol, les végétaux, les animaux et les humains.

De nouvelles séries d'échantillons ont donc été prélevés afin de dépister la présence de BPC dans l'ensemble. Des tests quantitatifs et qualitatifs de Dioxines et de Furannes ont aussi été effectués sur le quart des échantillons. Aucune modification aux directives antérieures n'a été jugée utile suite de ces analyses complémentaires.

NETTOYAGE ET RESTAURATION

Dans les heures qui suivent l'incendie, des travaux préliminaires sont entrepris pour éviter que des particules contaminées venant du site ne soient dispersées dans les champs, les quartiers voisins, les ruisseaux, la nappe d'eau souterraine, l'air ambiant. Mentionnons entre autre choses:

a) La mise en barils de tous les débris de l'incendie

b) le creusage de fossés et d'une lagune pour recueillir les eaux d'arrosage et les eaux de pluie

c) la mise en opération d'une unité mobile de décontamination des eaux

d) l'épandage d'une solution de chlorure de calcium pour éviter le transport aérien de particules

e) la construction autour du site d'une clôture de douze (12) pieds de haut pour contrôler l'accès

f) la mise sur pied d'une unité de décontamination du personnel

g) l'érection d'un chapiteau de 80 pieds par 120 pieds. Le but de cette structure temporaire réalisée en vitesse sert à empêcher les eaux de pluie et les vents de transporter ailleurs des cendres, suies ou émanations contaminées.

Lorsque le 9 septembre, à la suite de la recommandation des experts internationaux, le gouvernement autorise la réintégration des citoyens évacués, un programme de nettoyage des maisons, propriétés et édifices publics, est immédiatement enclenché pour éviter tout risque, si minime soit-il, de contact avec des contaminants potentiels. Grosso modo, le programme consiste dans:

- le lavage au double jet d'eau savonneuse et d'eau claire des surfaces lisses des édifices, meubles de parterre, etc.;
- la collecte des fruits et légumes des potagers et vergers domestiques;
- le nettoyage ou le remplacement des filtres à air des appareils de climatisation et thermopompes.

Le ministère de l'Agriculture du Québec pour sa part procède au déchiquetage et à l'élimination des produits végétaux provenant de 3,500 acres de terres agricoles commerciales.

La restauration du lieu de l'incendie reste l'opération la plus lourde et la plus complexe. Son exécution est prévue en deux étapes: d'abord la décontamination complète des lieux, puis l'élimination sécuritaire des BPC et des autres éléments contaminés recueillis sur les lieux. La première étape de cette opération est déjà en marche depuis le 6 octobre et les travaux consistent en:

- l'identification du contenu des barils, des transformateurs et des condensateurs;
- le nettoyage et la mise en sécurité à l'intérieur de conteneurs scellés, des barils, des transformateurs et des condensateurs;
- le démantèlement de l'abri temporaire (Chapiteau) recouvrant l'entrepôt incendié;
- le traitement des eaux contaminées du site;
- le traitement et le recyclage des solvants usés.

Quant à l'élimination des BPC et des autres résidus contaminés résultant de cet incendie, ni le procédé de destruction qui sera utilisé, ni l'endroit, ni les coûts ne sont connus à l'heure actuelle. Les autorités gouvernementales ont donné l'assurance de cette élimination et d'intenses négociations sont en cours à ce sujet.

CONCLUSION

La société, les divers paliers de gouvernements, l'industrie, le monde scientifique apprennent à partir des catastrophes!

Le monde industrialisé a vécu plusiers catastrophes écologiques attribuables en bonne partie à l'ignorance ou à l'inconscience reliée à la gestion des substances et déchets dangereux: Bhopal, Love Canal, Times Beach, Seveso.

Aucun pays, ne peut espérer échapper à cette dure réalité. St-Basile-le-Grand a rappelé aux Canadiens que cela peut nous arriver. Nos gouvernements ont sûrement réalisé qu'il est nécessaire d'assurer un contrôle strict des produits dangereux, depuis leur production, pendant leur utilisation, et jusqu'à leur destruction finale.

Le monde scientifique doit continuer à développer ses connaissances des effets de ces produits sur nos écosystèmes. Ils doivent conseiller les gouvernements et l'industrie sur une saine gestion environnementale.

L'industrie doit réaliser qu'elle a un rôle primordial dans la gestion de toutes les étapes de la vie de ces produits et qu'elle a la responsabilité de développer les moyens de disposer des déchets qu'elle crée.

La gestion en situation d'urgence, à cause du contexte particulier à l'événement et de la contraction du temps pour prendre des décisions, ne peut être comparée au temps normal. Il est donc nécessaire que les personnes qui ont à prendre charge durant un sinistre soient préparées à leur rôle par des sessions d'information et de formation particulières en gestion d'urgence et de crise.

PRACTICAL APPROACHES TO ACHIEVE PROFESSIONAL COMPETENCE FOR RESPONDERS IN DANGEROUS GOODS INCIDENTS

ROBERT D. SISK

REACT ATLANTIC INC.
HALIFAX, NOVA SCOTIA

PAPER UNAVAILABLE AT TIME OF PRINTING

TRAINING FIRE FIGHTERS FOR HAZ MAT RESPONSES

Len Mills
Office of the Fire Marshal

INTRODUCTION:

Hazardous materials are transported in enormous quantities. Gasoline, some diesel fuels, propane, sulphuric acid, anhydrous ammonia and butane account for most of the tonnage. In Canada, some 30,000 to 40,000 shippers and carriers move hazardous materials from some 50,000 points through municipalities coast to coast.

Accidents will and do happen regularly. Fire fighters must be prepared to handle an incident involving hazardous materials. Only through a comprehensive training program can the fire fighters hope to achieve this goal in a satisfactory and safe manner.

Our training program consists of a three level approach to attaining the necessary knowledge, skills and judgement for first responders certification in the control of hazardous material incidents.

The first level is a 16 Hour Awareness Course provided by our District Advisers to fire departments in their respective areas. Hands-on training is our second level. Some time is spent in the classroom where we teach classification, documentation, protective clothing, terminology and properties of hazardous materials. The remainder of the course is devoted to proper and safe methods of mitigation, including containment, confinement, decontamination, identifying containers, detection, plugging and patching, protective clothing and transferring of load.

Our third level which we plan to put into operation next year would be of interest to fire department officers with command responsibilities, and will include: emergency planning, incident management, command post, chemistry and toxicology, evacuation procedures and computer data base systems along with other command related material.

Awareness is certainly the most important element of the fire fighter training program. Without an awareness that hazardous materials are present, the fire fighter would enter a hazardous zone without full protective clothing and probably put water on a reactive chemical.

Notwithstanding the fact that awareness and command decisions are most important, I will devote the remainder of this paper to the hands-on level of training.

As we go through various training evolutions of plugging containers or confining, the students are required to wear level A-B-C or D protective clothing. Two-way radio communications are provided for work involving chemical suits, back up with hand signals. All evolutions are carried out under the careful eye of a safety officer.

Each type of chemical suit is described in detail and the instructor will give assistance to the student in donning the suit for the first time.

We purchased $250,000.00 worth of hazardous materials training equipment and then it was necessary to spend another $107,000.00 on a suitable vehicle to carry all this equipment. The main function of this vehicle is as a training unit, however it will respond to an incident when requested. It must be pointed out however that the vehicle and manpower must be available before the unit would respond to a hazardous materials incident.

The unit is equipped with a two-way mobile radio capable of 128 frequencies, a portable computer with a chemical information compact disk, a cellular telephone and air compressor for recharging air cylinders.

Many students receive their first look at a haz mat vehicle and the large array of equipment necessary to conduct a hands-on course.

Each student will have a turn wearing various types of protective clothing while carrying out assigned duties such as plugging holes in containers, or applying a patch to a tank car. Some may be applying a vacuum leak-seal patch while others train in confinement and containment.

During training in confinement, we teach how to construct an earth dam and weir, sump with overflow dam, fence and filter boom, hose boom, culvert plug and the use of absorbent materials.

We devote most of one day to stopping leaks in pressurized containers. Along with pipe bandages and other devices, we also instruct on how to apply a chlorine "A" kit and a "B" kit to leaking chlorine cylinders.

Throughout the hands-on training course, decontamination is set up and used after each training evolution is completed.

We stress the importance of setting up three separate zones. The Hot Zone, the Warm Zone and the Cold Zone. The actual patching or plugging, diking, ditch or containment takes place in the Hot Zone. Decontamination on the way out takes place in the Warm Zone. Decontamination also includes tools - self-contained breathing apparatus and encapsulated suits.

After decontamination, they proceed to the Cold Zone and report to the safety officer and medical officer.

In setting up our training area this way, we believe that the students learn not only how to stop or contain a leak, but also the importance of proper zones, wind direction, terrain and of course all the proper methods of decontamination.

We finish up the week with a simulated exercise where the students under their own site commander must "identify" the chemicals involved. Incorrect identification can lead to improper action. Next they must "assess" the situation and look at all the factors that may affect the incident and the response such as hazardous properties of the product, wind direction and speed, temperature, wet or raining weather and terrain. Consideration must be given to routes of access. Is it a leak, spill or fire? Are there casualties?

Now that we have identified and assessed the problem, we can determine the best response actions, we respond with caution and we teach our students to be prepared for a worst case scenario.

I have covered only a brief outline of our training program. It is impossible to describe in detail every segment of the program in the time allowed. If you need additional information, please call me at any time.

AUDITING
YOUR RESPONSE CAPABILITY

William F. MacKay
Sr. Transportation Safety Advisor
Esso Chemical Canada

In spite of the best efforts of industry and government to prevent hazardous material incidents from happening there is always the potential that an incident will occur. When one does occur it is essential that an effective emergency response network is in place to manage response to the incident and to protect the affected life, property, and the environment. This response network nearly always includes first responders, who may be part of the community's response plan, and frequently includes support from industry responders.

Since all components of government and industry response plans are not called upon frequently to respond to incidents, it is necessary to have means other than frequent use to determine that response plans are up-to-date and ready for immediate use. Auditing your response plan is one method of determining its degree of readiness.

Auditing emergency response capability is of interest to me from four perspectives:

- As a manager of our companies emergency response network
- As a team leader of a company response team
- As a member of a committee who manages an national mutual aid emergency response network
- As a member of the general public

I would like to elaborate on why I believe auditing is an essential component of maintaining that capability. I would then like to discuss the basic elements of auditing a response plan and review some of the material which is available to assist in evaluating an emergency response plan.

Why Audit?

As Sr. Transportation Safety Advisor with Esso Chemical Canada one of my responsibilities is the management of Esso Chemical's transportation emergency response network. Esso Chemical Canada is a member of the Canadian Chemical Producers' Association and subscribes to the Association's "Responsible Care" policy and codes of practice. Their six codes have been developed to ensure safe operations, and to protect employees, the public and the environment. One of the requirements of "Responsible Care" is to have the appropriate emergency response plans in place. Although the emphasis is clearly on prevention of incidents, emergency response is a very important and essential component. In my twenty two years with Esso Chemical and other subsidiaries of Imperial I have been involved with emergency response plans for much of that time. My experience over the years with various emergency programs has shown me the importance of the audit component in maintaining these plans. Because emergency plans are not needed or used on a daily basis it further increases the importance of auditing our plans over other parts of our operations which are used more frequently.

As a member of the Canadian Chemical Producers' Association TEAP committee which manages our mutual aid transportation emergency assistance plan "TEAP", I have likewise seen the importance of an audit in maintaining the readiness of emergency response capability within our association. Since the plan involves over 147 companies and eleven regional response centres, the audit function is even more important because each company needs to be assured that the other companies are in a state of readiness to help them if the need arises. Auditing within TEAP was introduced a number of years ago and continues to be important with one of our more active subcommittees devoted to it.

As a member and one of the on-scene commanders of the Imperial Oil national emergency team "NET", I may have to depend on other members of the team and it's support systems. This gives me a very personal interest in ensuring our plans work every time. The development of standards for the operation for this team and verification that the standards are being adhered to is a factor which ensures the continued success of this team.

Now, putting on my hat as a member of the general public, all I have to do is watch the evening news to see the growing importance which the public is expecting regarding the protection of people and the environment from injury or damage as the result of exposure to dangerous goods. This involves primarily programs to prevent incidents but also incorporates the emergency plans which must be in place in case an incident occurs.

As you are well aware, governments react to public pressure and consequently Transport Canada has undertaken the auditing of emergency response plans in the latter part of 1988 under the authority of the Transportation of Dangerous goods act.

In summary, auditing emergency response capability seems to be expected today by those who may have to call upon a response plan as well as those who manage and participate in the plans.

Audit Components and Assistance:

Having now established the expectation that emergency response plans should be audited lets look at the components of a good audit, and where assistance can be obtained to help you audit your plan. I will try to incorporate aspects of auditing community emergency plans as well as evaluating the elements of company response teams.

First, before we begin to look at emergency system audits, let's look at audits in general. One of the most widely used audits within industry is the International Safety Rating System of the International Loss Control Institute[1]. This organization has developed an audit which is used to evaluate the management systems in place to help member organizations operate safely. In addition to being a key tool to help prevent incidents which can lead to the need for emergency response it can also be adapted to evaluating emergency systems themselves. The key to auditing is to focus on the management systems that are in place to ensure a plan continues to operate in the long term instead of concentrating on the details. Setting up your emergency response plan can be a challenging task but keeping it in operation over the long term is the real challenge.

Looking specifically at emergency response plan auditing I would now like to consider guidance available from:

- Transport Canada
- The Canadian Chemical Producers' association
- U.S. Government Agencies

Transport Canada[2] offers two the following items which can be of assistance in developing and evaluating your emergency response plan. The first is a publication entitled "Guidelines for preparation of Emergency Response Assistance Plans. This document provides guidance to assist companies develop or evaluate their emergency response plans. These guidelines may be obtained from Transport Canada or are included in the CCPA Transportation Code of Practice Standards Guide.

The other useful item provided by Transport Canada is the form used by their inspectors to evaluate emergency response plans. Although it does not contain detailed questions it indicates the following areas which will be evaluated:

Plan activation
This section requests evaluation of the plans internal alerting mechanism, the ability to conduct a situation appraisal, ability to mobilize resources, and authority to activate the plan.

Response tasks:
This section provides for evaluation of the plan's external alerting mechanism, and ability to take action to contain and clean up as the result of an emergency.

Resources:
Resources which are required to operate the plan include contact listings, a communications system, logistics support, equipment, materials, and personnel. Mutual aid resources are also evaluated in this section.

Preparedness:
This section includes conducting a hazard analysis, evaluation of response team training, exercises and investigation follow-up, maintenance of response equipment, and the distribution of the plan.

The Canadian Chemical Producers' Association:

To aid member companies in complying with the Transportation code of practice the CCPA[3] developed a standards assessment. The standards assessment contains a series of questions to help evaluate various aspects of compliance with the Transportation code of practice. Section three of this assessment contains questions designed specifically to help member companies evaluate their emergency response plans. The emergency response section of the assessment was developed by the TEAP Audits and Admissions Committee to help member companies pass the Transport Canada review of their emergency response plans. It will be upgraded periodically based on input received from audits conducted on member companies and revised standards of training and equipment as established by the TEAP committee. Copies of this assessment are included at the end of this paper.

U.S. National Response Team:

U.S. Federal regulations require communities to prepare emergency response plans. To aid in the preparation of these plans the National Response Team[4] which is comprised of representatives from fourteen U.S. federal agencies has developed a publication entitled "Hazardous Materials Emergency Planning Guide" which was issued in March of 1987.

This guide provides background material on the planning process, and existing government and industry components of the overall plan. Guidelines on the selection and organization of the planning team, and the tasks of the team, are provided in the guide. The guide addresses the development of both single and multi-hazard plans for communities and provides many useful suggestions. Although not written as an audit guide this publication can be used as a valuable aid in evaluating an existing plan.

Summary:

In summary, there are written guidelines and checklists available to help evaluate response plans, and personnel both in government and industry who are available to provide advice and assistance. Have you taken advantage of these resources to evaluate your response plan?

The best way to evaluate any plan is to actually use the plan. It should be used as documented to respond to incidents, and the tendency to shortcut or work around the plan should be avoided. Use of the plan can also be accomplished through simulations. The key to a good plan evaluation is to keep accurate records during the response, and to conduct a thorough evaluation of the response, involving the participants, as soon as possible. It will usually yield numerous suggestions for improvement which must be assigned for follow up.

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[1] International Loss Control Institute, Highway 78, P.O. Box 345, Loganville, Georgia, 30249, U.S.A.

[2] Transport Canada, Transportation of Dangerous Goods Branch, Place de Ville, Ottawa, Ontario, K1A 0N5 (613) 991-9396 Attention Edgar T. Ladouceur.

[3] The Canadian Chemical Producers' Association, 350 Sparks St., Suite 805, Ottawa, Ontario, K1R 7S8. Phone (613) 237-6215.

[4] National Response Team of the National Oil and Hazardous Substances Contingency Plan, G-WER/12, 2100 2nd. Street SW, Washington, D.C. 20593, U.S.A.

TRANSCAER Emergency Response Standards Assessment

		Work not started to achieve compliance	**Work is in progress to achieve compliance**	**Completed**
1.0	Is the plan documented?	☐	☐	☐
2.0	Has the responsibility for the management and distribution of the plan been assigned?	☐	☐	☐
3.0	Does the plan contain:			
3.1	• a policy statement of the corporate commitment to emergency response?	☐	☐	☐
3.2	• product hazard information: do you have material safety data sheets for all products which may require an emergency response?	☐	☐	☐
3.3	• a summary of Schedule XII products shipped by mode, container type and Canadian destinations? (general vs. detailed)	☐	☐	☐
3.4	• training requirements			
3.4.1	• do all company personnel who are part of the plan receive training of the overall operation of the plan?	☐	☐	☐
3.4.2	• do all response team members receive general hazard awareness training which includes: - awareness of 9 classes of dangerous goods - TDG certification, where applicable - personal protective equipment	☐	☐	☐
3.4.3	• are team members who may be called upon to use specialized equipment trained in its operation? (i.e. SCBA, capping kits, etc.)	☐	☐	☐

TRANSCAER Emergency Response Standards Assessment

Completed
Work is in progress to achieve compliance
Work not started to achieve compliance

3.4.4 • is the training content documented (lesson plans) for each position? ☐ ☐ ☐

3.4.5 • are records maintained for training given? ☐ ☐ ☐

1.4.6 • does the training include simulation of emergencies to evaluate all response procedures and overall plan effectiveness? ☐ ☐ ☐

3.4.7 • are the team leaders trained in tactics, strategy and decision-making? (i.e. Disciplined Approach) ☐ ☐ ☐

3.4.8 • does the training include site safety and decontamination procedures? ☐ ☐ ☐

3.4.9 • does this training cover products specific to your company? ☐ ☐ ☐

4.0 Activation procedures

4.1 • do you have a 24-hour E/R phone? ☐ ☐ ☐

4.2 • does the person answering the emergency number use a questionnaire to obtain situation appraisal data? ☐ ☐ ☐

4.3 • are procedures to alert co-ordinators / response personnel documented? (flow chart) ☐ ☐ ☐

4.4 • do procedures include the appropriate authorizations to activate the plan and commit resources? ☐ ☐ ☐

4.5 • are the activation procedures tested at least quarterly ? ☐ ☐ ☐

TRANSCAER Emergency Response Standards Assessment

		Work not started to achieve compliance	Work is in progress to achieve compliance	Completed
5.0	Response procedures			
5.1	• communications does the plan include ?			
5.1.1	• the necessary procedures and equipment to communicate between the home co-ordinator and the incident scene?	☐	☐	☐
5.1.2	• appropriate equipment and / or procedures for communication between personnel at the scene?	☐	☐	☐
5.2	• reporting does the plan include?			
5.2.1	• procedures to notify the appropriate government agencies and authorities?	☐	☐	☐
* 5.2.2	• procedures for internal and TEAP reporting requirements?	☐	☐	☐
5.2.3	• procedures / equipment for documenting incidents?	☐	☐	☐
5.3	transportation does the plan include?			
5.3.1	• provision for transportation of personnel and equipment to potential incident location as rapidly as possible?	☐	☐	☐
* 5.3.2	• provision for having the technical advisors on scene within 6 hours as required?	☐	☐	☐

TRANSCAER Emergency Response Standards Assessment

Completed
Work is in progress to achieve compliance
Work not started to achieve compliance

* 5.3.3 • provision for sending a back-up team within 24 hours as required for a TEAP response? ☐ ☐ ☐

6.0 Emergency contact list

Does the plan include contact lists for:

6.1 • home co-ordinators ☐ ☐ ☐

6.2 • E/R team members ☐ ☐ ☐

6.3 • technical advisors (TEAP Contact) ☐ ☐ ☐

6.4 • support personnel (medical, public relations, industrial hygiene, legal, product specialists, etc.) ☐ ☐ ☐

6.5 • management contacts ☐ ☐ ☐

6.6 • government agencies ☐ ☐ ☐

6.7 • transportation resources (for team and equipment) ☐ ☐ ☐

6.8 • environmental specialist ☐ ☐ ☐

* items indicate pertain specifically to signatories of the TEAP contract

7.0 Equipment

3.7.1 • does the plan include a list of available equipment essential to the operation of the plan? ☐ ☐ ☐

TRANSCAER Emergency Response Standards Assessment

Completed
Work is in progress to achieve compliance
Work not started to achieve compliance

7.2 • does the equipment listed include the analytical, personal, protective, containment and recovery equipment required to respond to all product/modal shipping combinations of your products? ☐ ☐ ☐

7.3 • does the plan provide for responsibilities and procedures for maintenance of equipment? ☐ ☐ ☐

8.0 Contractual agreements

8.1 • does the plan include contractual arrangements for E/R resources (where a company does not have its own initial response team)? ☐ ☐ ☐

8.2 • is a signed copy of any contractual arrangement included in the plan? ☐ ☐ ☐

9.0 Environmental considerations

9.1 • does the plan include provision for training technical advisors for actions to be taken when products are released into the environment (air, water, land)? ☐ ☐ ☐

9.2 • does the plan include methods for dispersion analysis and disposal of products? ☐ ☐ ☐

End of TEAP audit section

10.0 The company has made provision for resources to help the association in training first responders. ☐ ☐ ☐

TRANSCAER Emergency Response Standards Assessment

	Work not started to achieve compliance	Work is in progress to achieve compliance	Completed
11.0 The company has identified the government agencies which might be encountered in responding to a transportation emergency and has made provision for co-operating with them at the incident scene.	☐	☐	☐
12.0 The company has adopted a policy and developed procedures to provide immediate and short-term assistance, if appropriate, to persons who are dislocated by a transportation emergency.	☐	☐	☐

How to Design and Run a Test Exercise

Wayne Brocklehurst
Emergency Planning Ontario

Exploiting the Emergency Plan

The need to formulate emergency plans is generally accepted by all orders of government and that general acceptance extends to many elements of our society such as industry, institutions and voluntary agencies. Considerable energy and determination is required to formulate that initial plan because it may well explore the unknown, inevitably runs up a bill in human and material resources and disturbs the status quo. The satisfaction which comes from achieving that goal is short lived however, because the constant changes to the plans's environment and the changes in key personalities can soon negate the plan's validity. The answer, as we all know, is to exercise or test that plan on a regular basis.

The risk assessment, the consultation, the coordination, the solutions, the written drafts and final approval may have presented considerable obstacles at the time, however with hindsight those obstacles are often no more than the usual challenges to be expected of any new endeavour. With that assurance in mind it should be possible for the same planning team to undertake the ongoing process of validating and updating the plan. This paper aims to discuss some simple exercise principles and provide some practical advice on how to design and run a test exercise.

Types of Exercise

Exercises come in any number of variations. This paper groups these variations into types merely for simplicity and these types are not intended to be rigid in their form or definition. Before deciding on an exercise type some understanding of the advantages and disadvantages of each is useful.

A Type 1 exercise is one in which a realistically simulated event occurs within the plant and requires specific plant personnel to respond in a realistic manner. The scope can be varied to include only a small section of personnel or can be broadened to include larger numbers and outside first responders (police/fire/ambulance). The aim of such exercises is usually to test in plant procedures and to ensure that specific personnel perform those procedures appropriately.

Advantages

- little advance planning is required once procedures have been developed and personnel trained
- they serve as an ongoing safety programme and quality assurance programme
- they can be created, evaluated and followed up by immediate supervisors
- they can be either no notice or announced exercises.

Disadvantages

- they can be disruptive to productivity
- participants may be uncomfortable with the evaluation process
- a mechanism for ensuring supervisor objectivity must be created.

A Type 2 exercise is one in which appropriate plant personnel identify an event as being beyond or likely to be beyond their capability to immediately control. The emergency plan is then activated utilizing the specified alert mechanism. The scope can be limited to an in-plant alert or can be broadened to include local municipalities. The aim of such exercises can be two-fold; to train first responders to recognize when a "routine operation" becomes an emergency, and to test the alert procedure.

Advantages

- the exercise is of very short duration and requires little prior preparation
- it ensures that key personnel contact or alert lists are kept up to date
- it assists all personnel understand the limits of their authority and responsibility.

Disadvantages

- a no notice alert may alarm some members of the public
- the short duration of such exercises does not allow the effect of pressure to manifest itself on personnel.

A Type 3 exercise is one in which supervisory personnel assess a theoretical problem (case study) are subjected to inputs from exercise control staff and present their solutions. The scope can range from an in plant problem which can be resolved internally to one which requires interaction with the surrounding municipality(ies). The aim of such exercises is usually to familiarize supervisors and key municipal officials with the provisions of emergency plans and to allow them to gain confidence in their ability to interact with a wide range of officials not normally encountered on a regular basis.

Advantages

- they do not disrupt productivity
- they require few material resources
- they allow supervisors and their individual backups to be trained alike
- there is no real world consequence of error
- procedural weaknesses are identified.

Disadvantages

- they require a control staff and a script of varying complexity to be created by non players
- the theoretical nature of the problem can allow players to be unrealistic in their timings and solutions
- resource weaknesses cannot be easily identified
- issues of compatibility or concurrent activity do not arise unless a large control staff is able to create those issues during exercise play

A Type 4 exercise is one in which a realistically simulated event occurs within the plant, has the potential for significant external impact and requires personnel to respond in a realistic manner. That response includes activation of the emergency plan and the involvement of local municipal officials and perhaps selected members of the public. The scope is limited only by the degree of training, the willingness of non-plant personnel to participate and the resources available to support the exercise.

Advantages

- all aspects of a plan and most key players are exercised in context
- limitations or weaknesses are fairly easy to identify
- a successful exercise contributes to a positive climate of trust and confidence between all persons
- such exercises help to sensitize the general public to the role expected of them in an emergency.

Disadvantages

- a significant amount of pre planning is required to stage this type of exercise
- the success of the exercise is directly related to the training level of all participants
- such exercises are costly in resources
- the public may be inconvenienced as a result of the exercise.

Combining exercise types can create additional types however that need not be considered at this time.

Without getting into a long discussion on the behavioral or motivational aspects of testing, practical experience suggests the avoidance of some common pitfalls. Do not attempt a Type 4 exercise as your initiation into the exercise world. Many of the players will be unfamiliar with their role or how it impacts on others. Lack of confidence can result in cautious or indecisive action, or worse still, avoidance of the exercise. Your chances of successfully achieving your exercise goals are therefore somewhat slim. Select less ambitious exercise types to build skills and confidence and once that is achieved, you can invest the resources into a Type 4 exercise with some assurance of success.

Do not attempt any type of exercise without a prior training session. The training session may range from a review of individual responsibilities, a run through of the procedures to be tested, use of check lists during the test, or advance distribution of the exercise script (it encourages players to review specific procedures prior to the exercise).

Do not attempt any type of exercise without first selecting an exercise goal and arranging a control mechanism to ensure that goal is met. Selecting the goal is quite simple. It usually consists of a test of procedures and/or a test of individual responsibilities and/or a test of the communication or interaction between participating agencies.

Once a goal(s) and the type of exercise have been selected the exercise scenario can be prepared. Some imagination is required to create a worthwhile scenario. You can create a scenario which surprises the players; it should not astonish them! The best scenarios for exercise purposes are ones which present limited risk initially but have a high potential for catastrophic risk as the exercise develops. The uncertainty presented by this type of scenario encourages the players to carefully think out their actions and to consult with one another. It also provides the exercise director with a flexible control device. He can speed up or slow down events to match the progress of the players as they strive to meet the exercise goal(s).

Control Mechanisms

The control mechanism for any exercise is very important. The mechanism ensures that exercise events are not mistaken for real world events and as already mentioned, it ensures that the exercise players focus on the pre-selected goals and do so in timely fashion. Control mechanisms can be very simple. A supervisor gives a verbal description of a problem to an operator and requests a demonstration of the corrective action. In this Type 1 exercise the supervisor ensures that other personnel do not misinterpret the purpose of the drill and ensures that the operator reacts in a safe manner. A Type 4 exercise could involve an exercise instruction of several hundred pages and a control staff of similar magnitude.

The scope of the exercise and therefore its complexity determines the size and sophistication of the control mechanism. Before discussing the mechanism a word on some of the more popular control tools which form part of the control mechanism might be helpful. Those that exist only in the make believe world force players to think and those that exist only in the real world have a habit of thwarting otherwise brilliant solutions.

Weather. Use actual weather whenever possible. Players can manage the problem under realistic conditions and all outside supporting data or advice does not have to be interpolated. Try to exercise winter scenarios during winter and summer scenarios etc. If the achievement of exercise goals requires a very specific weather condition, that condition should be drawn to players' attention frequently during exercise play to enable them to manage the problem in the proper context. As an example, if a worse case scenario is being exercised and the prevailing winds are not cooperative, a fixed number can be added or subtracted to the actual wind direction and speed at the start of the exercise to contrive that worse case.

Time. Certain exercise goals associated with the confirmation of a procedure, such as the alerting of personnel and their response time, can only be achieved in real time. Compressing or expanding real time to achieve that goal teaches false lessons. The time available to exercise a plan or a portion of it may fall short of the usual time it takes to conclude a similar problem in the real world. Matching exercise time to real world time may result in activity gaps or lack of pressure for the exercise players, or conversely it may prevent the players from examining all solutions in detail. The exercise director must decide which time condition will best assist in achieving the exercise goals and advise the players appropriately.

Communications. Players must have a means of informing themselves about a problem and taking appropriate action to resolve the problem. In its simplest form a player could observe the problem and either solve the problem himself or give verbal direction to others. If the player cannot observe the problem personally because of obstacles, or would not normally have that capability, or if the exercise scope calls for a theoretical problem, then the players must have other forms of communication with the site. Those communications should duplicate to the greatest extent the communications that would be available in an emergency and all of their attendant problems. The media, both as a means of passing vital information to the public and in their role of covering newsworthy events on behalf of the public, can be considered an element of the control mechanism.

Logs. A record of events, the time the information was received, the action taken and the time of that action is essential both in an operation and during an exercise. The log provides a running summary of the situation, helps to ensure that all matters eventually get addressed and in the aftermath, helps to overcome the vagaries of memory.

Umpires/Evaluators. An umpire is a member of the control cell tasked with resolving unknowns on the spot during an exercise. As an example, an exercise may call for a simulated fire at the site. An umpire would interpret the techniques of the operators and applying his own expertise, would arbitrarily determine when the "fire" had been extinguished. An evaluator is a member of the control cell tasked with observing the action of individuals or the impact of such action on procedures. They can be employed in an operation or in an exercise. It is important to stress that their role is one of impartial observation to enable the operation or exercise to be objectively analyzed after the event.

Inputs. Information provided to players by telephone, radio, hard copy or verbally is collectively referred to as an input. The input can be controlled, uncontrolled or a combination of both. A player could contact a weather centre to obtain a forecast and receive the actual forecast (uncontrolled input) or if the weather centre had agreed to participate in the exercise, the player could receive an exercise forecast (controlled input) or the exercise director could designate a specific telephone number for weather information and have a member of the control staff provide a combination of exercise and actual weather as considered appropriate (combination input). Some inputs are initiated by players and some are initiated by control staff. Regardless of the origin of the input it should be tracked to its conclusion by the control staff. That tracking can take the form of post exercise log analysis, by having control staff make inquiries regarding the status of the input, or by employing umpires and evaluators.

Incident List. An incident list is a script which details the flow of an exercise. It is used by control cells to provide inputs to players at fixed times or at the discretion of the exercise director. The list can be divided into a master list containing those inputs which must be communicated to the players and a supplementary list which contains discretionary inputs to be used to assist or hinder players in their decision making should the exercise director consider that to be necessary. The list can be released to players in advance of an exercise if it is more beneficial to achievement of the exercise goals than the effects of surprise.

Higher Control Cell. Members of this cell represents senior level agencies or managers to whom a player would normally report or from whom they would seek direction. The exercise director may choose to have staff represent these agencies/managers, or through prior arrangement could have the agencies/ managers represent themselves and report player inputs to the exercise director. The higher control cell can provide inputs to players or respond to inputs from players. The cell should not be co-located with the players.

Lower Control Cell. Members of this cell represent those personnel who normally perform the tasks required by the players. Cell members initiate inputs to players or respond to inputs from players. They should not be co-located with players.

Developing the Exercise Programme

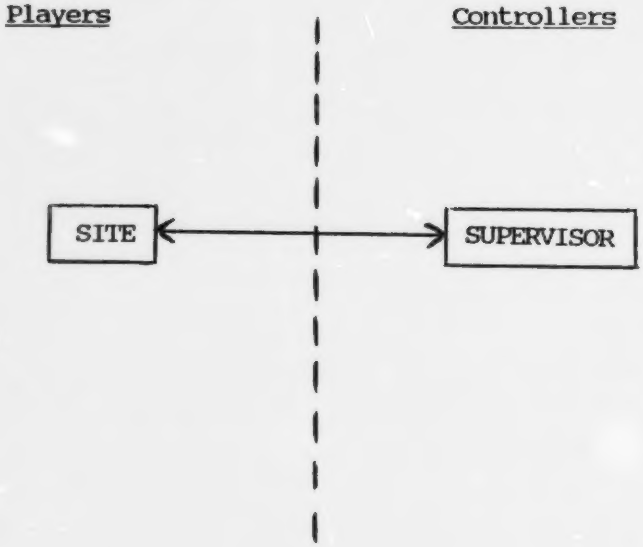
Emergency management essentially employs a two tiered system. The primary tier of management occurs at the site and a group of first responders, coordinated by either a pre-designated responder or one selected by themselves, performs the necessary actions to control the problem. When the problem becomes or threatens to become a problem of such proportions that first responders cannot control the situation, or complex coordination of many outside resources is necessary, or the problem threatens the health and safety of significant numbers of people and large amounts of property, the second tier must be alerted. The second tier provides overall executive guidance to the primary tier, acquires the necessary resources to support the primary tier, manages problems occurring away from the site and coordinates its action with other jurisdictions. A plan whether created for a plant, a municipality, an institution or another order of government is generally formulated in this manner. Its elements usually consist of a statement of the plan's purpose, the conditions which should exist to activate the plan, who is authorized to activate the plan, the alert system, the location of control centres, the responsibilities of key officials and any special or standing procedures to be followed. It may include attachments such as a communications diagram, a resource directory, maps, evacuation routes, important telephone numbers etc.

For our purposes we will assume that a chemical plant located in a rural area, astride a major transportation corridor has developed a plan based on the foregoing model. The plan has been coordinate with local municipal plans. The plant is developing an exercise programme. It has been decided to implement the following programme over the next 24 months.

Phase 1

- conduct training sessions to ensure operators perform normal functions to a standard
- conduct training sessions to ensure operators recognize and take immediate and appropriate action to control problems
- conduct training sessions to ensure supervisors develop or monitor operating procedures
- conduct several Type 1 exercises.

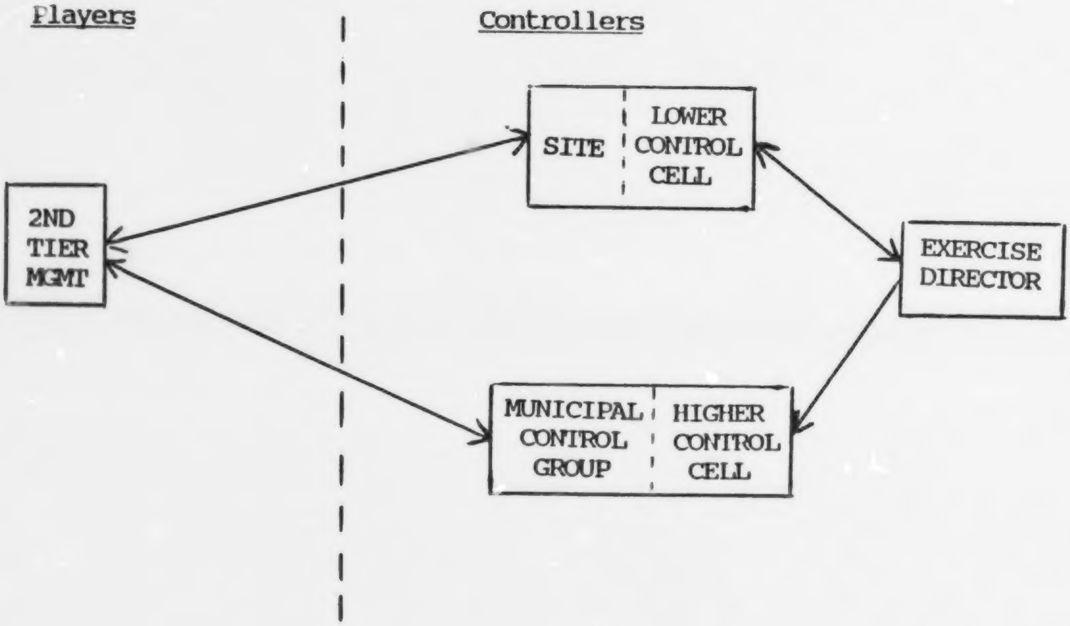
Type 1 Exercise


Players
Controllers
SITE
SUPERVISOR

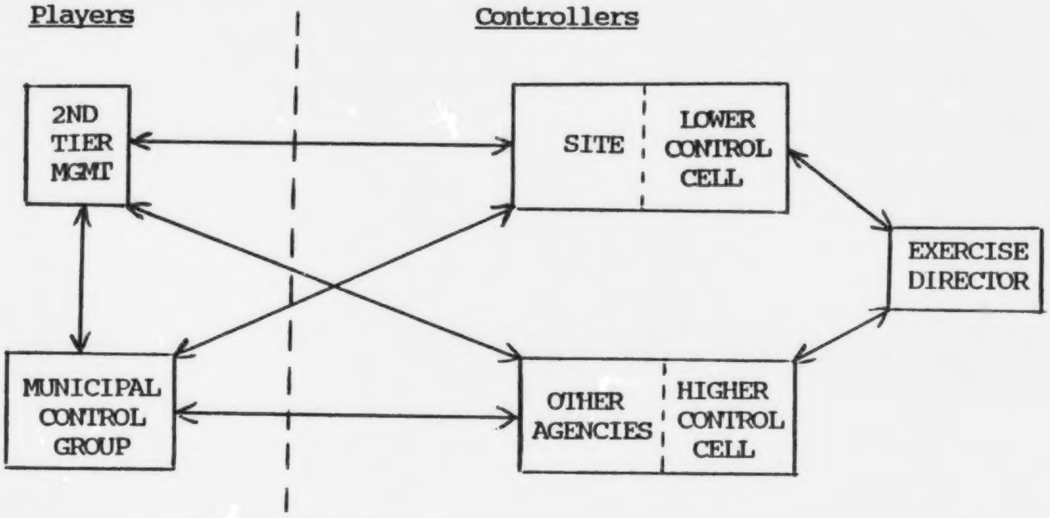
Phase 2

- conduct training sessions to ensure the second tier management team are familiar with their responsibilities and the provisions of the plan
- conduct training sessions to familiarize the second tier management team and key municipal officials with the provisions of each other's plan
- conduct a Type 3 exercise for the second tier management team
- conduct a Type 3 exercise for the second tier management team and the municipal control group.

Type 3 Exercise (Plant only)


Players
Controllers
2ND TIER MGMT
SITE
LOWER CONTROL CELL
EXERCISE DIRECTOR
MUNICIPAL CONTROL GROUP
HIGHER CONTROL CELL

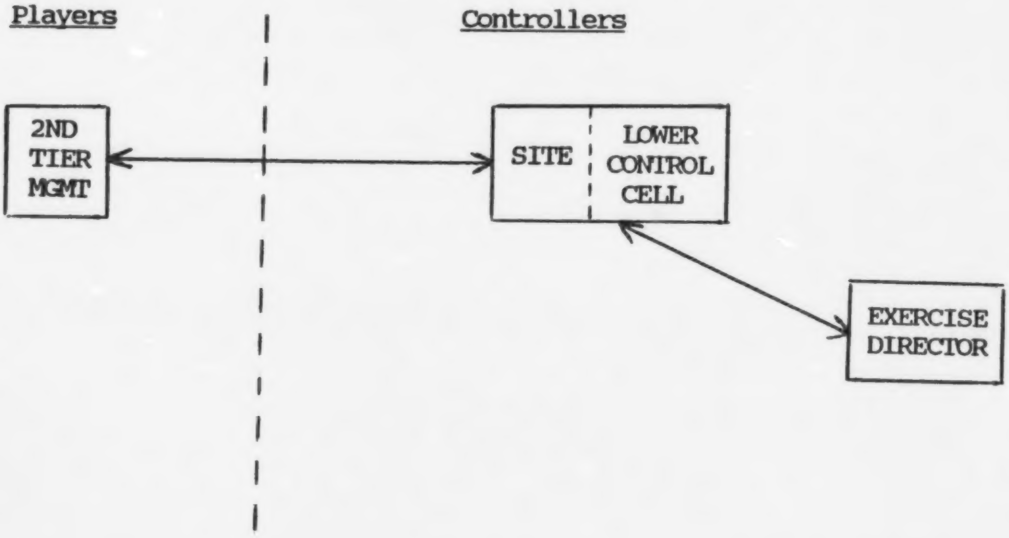
Type 3 Exercise (Plant and Municipality)


Players
Controllers
2ND TIER MGMT
SITE
LOWER CONTROL CELL
EXERCISE DIRECTOR
MUNICIPAL CONTROL GROUP
OTHER AGENCIES
HIGHER CONTROL CELL

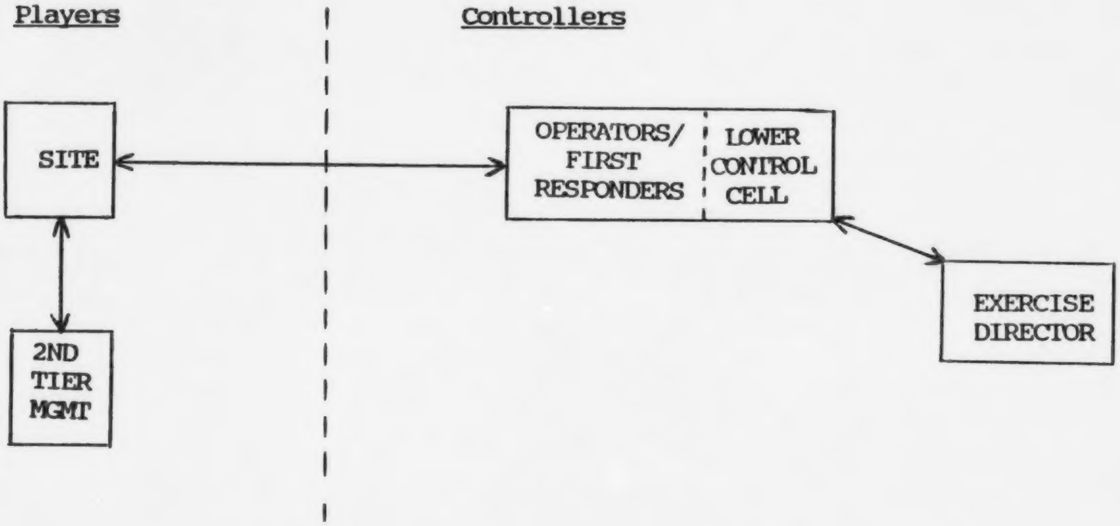
Phase 3

- conduct training sessions to familiarize all personnel with the alert system
- conduct a Type 2 exercise to practice the alert system
- conduct training sessions to ensure that operators and their supervisors are familiar with the conditions leading to or likely to lead to an emergency
- conduct a Type 2 exercise to practice emergency identification and the alert system.

Type 2 Exercise (Alert only)


Players
Controllers
2ND TIER MGMT
SITE
LOWER CONTROL CELL
EXERCISE DIRECTOR

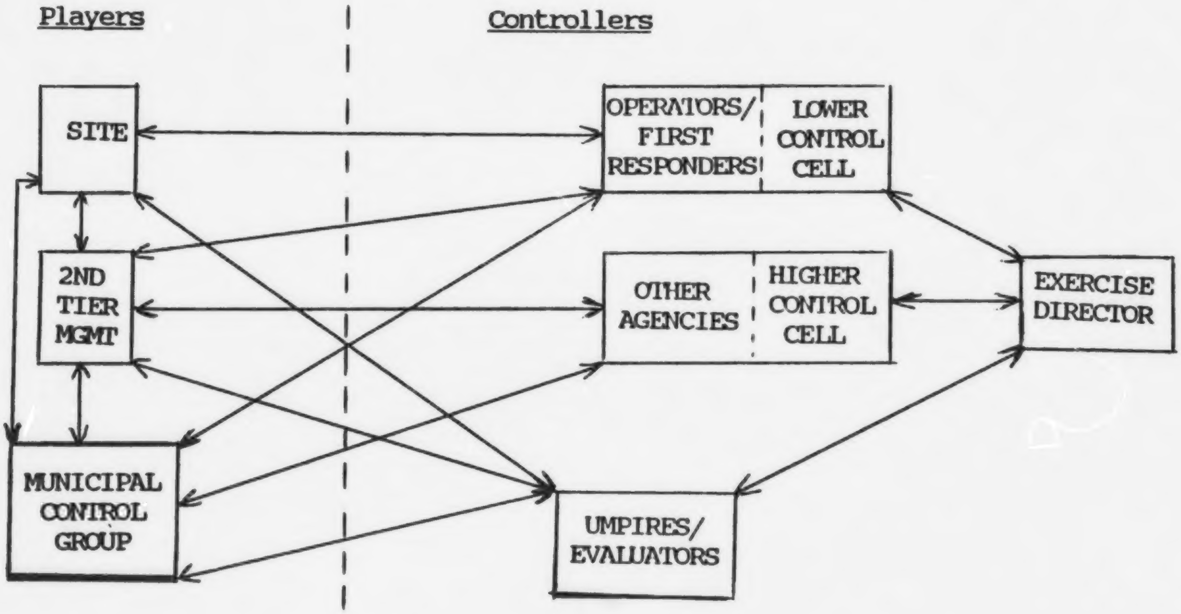
Type 2 Exercise (Emergency Identification and Alert)


Players
Controllers
SITE
2ND TIER MGMT
OPERATORS/ FIRST RESPONDERS
LOWER CONTROL CELL
EXERCISE DIRECTOR

Phase 4

- conduct training sessions to familiarize all players with the provisions of the plan
- conduct a Type 4 exercise in conjunction with the local municipality.

Type 4 Exercise


Players
Controllers
SITE
2ND TIER MGMT
MUNICIPAL CONTROL GROUP
OPERATORS/ FIRST RESPONDERS
LOWER CONTROL CELL
OTHER AGENCIES
HIGHER CONTROL CELL
EXERCISE DIRECTOR
UMPIRES/ EVALUATORS

At the completion of any phase it is important to debrief both players and controllers to determine weaknesses in the procedures and arrangements. Corrective action must be taken prior to any further exercises or if that is not possible, identify the weakness and work around it, ensuring that players are aware that this is purely a temporary expedient.

A study of the exercise programme discussed in this paper should lead the reader to conclude that such a programme can be varied to suit any number of local conditions, as can the sequence of the programme. The point is that unless you take a plan and make that the focus of an exercise programme you have not made any progress in emergency preparedness. The Canadian Emergency Preparedness College at Arnprior conducts a one week course on exercise design. The training is fully funded by the government of Canada and you can apply for a vacancy through your provincial emergency agency or directly to the College if you are a federal government employee. One final tip which may help you design and run test exercises is to read the plan and note any grey areas or procedures which don't strike you as solid. A scenario which forces that aspect to be examined may result in the creation of a better procedure or provision in the plan after the exercise.

Coordination of Planning an Exercise

Larry D. Abbott
Regional Municipality of Ottawa-Carleton

Overview

On 10 June 1988, the Regional Municipality of Ottawa-Carleton conducted a large scale disaster exercise, named Boldstep, which involved over 1000 people from 55 different organizations. The scenario was a toxic chemical spill of hydrochloric acid from a traffic accident between a tanker trailer and two buses on a bridge.

The objectives of the exercise were to:

- test the recently developed Regional Emergency Plan
- exercise the inter-operability of emergency services
- operate a Regional Evacuation Centre, and;
- operate a Regional Emergency Operations Centre.

The Regional Municipality of Ottawa-Carleton consists of 11 municipalities with 10 fire departments, 6 police forces, 12 hospitals and 4 ambulance services. Added to the emergency services were the individual municipalities, various support services, the Regional Government and the Federal Government. The participants in the exercise were;

- Ottawa Police *
- Gloucester Police Force *
- Nepean Police Force *
- Ontario Provincial Police *
- Royal Canadian Mounted Police
- Hull Police Force
- Ottawa Fire Department *
- Gloucester Fire Department *
- Nepean Fire Department *
- Cumberland Township Fire Department
- Osgoode Township Fire Department
- Ottawa-Carleton Regional Ambulance Services *
- Winchester Ambulance Service *
- Nepean Ambulance Service *
- Rockland Ambulance Service *
- Children's Hospital of Eastern Ontario *
- Montford Hospital *
- National Defence Medical Centre *
- Ministry of Health,
- Ministry of Environment *
- Ministry of the Solicitor General
- Ministry of the Attorney General

- Ministry of Transportation and Communications
- Ministry of Natural Resources
- Ministry of Community and Social Services
- Ontario Fire Marshal
- Emergency Planning Ontario
- Regional Coroner *
- Regional Department of Health *
- Regional Social Services Department *
- Regional Works Department *
- Regional Transportation Department *
- Regional Legal Department *
- Regional Clerks Department *
- Regional Planning Department
- National Capital Commission
- Parks Canada
- Environment Canada
- Transport Canada *
- Health and Welfare Canada *
- Emergency Preparedness Canada
- Canadian Coast Guard
- Canadian Chemical Producers Association
- Ottawa-Carleton Separate School Board *
- Ottawa-Carleton Red Cross Society *
- The St John Ambulance *
- The Salvation Army *
- Dupont Canada *
- Travelways Bus Lines *
- Victorian Order of Nurses *
- Ottawa-Carleton Transit Commission *
- XM 49ers Radio Squadron *
- React Radio Club *
- Emergency Measures Amateur Radio Group *
- The Ottawa Sun *

* = direct involvement in the exercise

Coordinating the involvement of all the organizations to meet our objectives was a difficult but not impossible task.

Planning Meetings

We began preparing for the exercise a year before the exercise date. We held a first meeting with all the organizations involved and attendance was well over 100. The purpose of the first meeting was to outline the exercise objectives, and to introduce the participants and their roles.

We realized that planning anything with a group of 100 was impossible, so all future meetings were divided into specific interest groups. Each sub-committee was chaired by the Senior Exercise Director who ensured that all participants received reports of every sub-committee meeting.

The organizations were divided into sub-committees of;

- Police
- Fire
- Medical
- Support Services
- Technical Advisors
- Media
- Umpires/Evaluators
- Communications

Meetings of each sub-committee were held every six weeks and a general meeting of all participants every three months.

Jurisdiction

As there are 11 municipalities in the Region we wanted direct involvement from the major cities of Ottawa, Gloucester and Nepean, and support from the smaller communities. As a disaster site we selected a Regional bridge that forms the border of the three large cities.

Our selection of the Hunt Club Bridge resulted in added problems, in that it involved more organizations than we had anticipated.

- The bridge on the Rideau River is owned by the Regional Government,
- one of the access roads is a Provincial Highway,
- the embankment is owned by the National Capital Commission of the Federal Government,
- the water flow is controlled by Parks Canada,
- the waterway is policed by the Ottawa Police, Ontario Provincial Police and RCMP,
- any chemical spill into the waterway involves the provincial Ministry of Environment and Environment Canada,
- and the provincial Ministry of Natural Resources monitors fishing on the river.

Costs

The Regional Government budgeted $20,000 for its own internal costs and we stated from the outset that each organization had to absorb its own costs. Throughout the exercise planning there was a growing concern about the costs to conduct the exercise, particularly from the police, fire and medical services. Overtime costs to recall staff was a prime factor. We purposely selected a Saturday to conduct the exercise, as holding it on a weekday when most agencies have a full complement of staff results in a deceptive response. History has proven that most major emergencies occur during off hours. A Saturday was also selected as the exercise was being held on a major bridge and there would be minimal disruption to traffic. Each organization provided a letter of commitment to the exercise.

Phases

As we now had commitment from the agencies involved we had to ensure they were physically involved in the exercise. We developed the exercise in phases which were;

- Phase I - disaster on the bridge,
- Phase II - evacuation
- Phase III - operations centre

Each phase interacted with each other and during the exercise all phases were conducted simultaneously. An Exercise Director was appointed for each phase and umpires/evaluators allotted to each phase.

The timing for the exercise and who would be called first was kept secret.

Expert Advice

Ottawa-Carleton is the only Regional government in Ontario that does not have its own police and fire service. To provide guidance and to properly exercise these agencies we used the sub-committee of umpires/ evaluators to assist us in designing exercise inputs. We selected officials from outside the Region and from municipalities not involved to provide unbiased opinions. To prevent embarrassment to the agencies we ensured that the reports of the evaluators were channeled through the Senior Exercise Director.

The technical advisory sub-committee provided the expertise in developing the mechanics of a toxic chemical spill and the type of response required.

Coordination

Each individual emergency and support service do an excellent job within their own field of expertise and municipality. Exercise Boldstep was designed to force organizations to work beyond municipal boundaries. As each emergency service use their own radio frequencies, the Emergency Measures radio network was used to pass operational traffic from the disaster site to the Operations Centre. A separate emergency radio network is essential when dealing with numerous agencies. It proved so useful that it is now used as a backup to the 911 system.

In developing the Regional Emergency Plan we realized that dealing with so many organizations and their respective chiefs would be difficult under emergency conditions. Our Plan designates only one police and fire official at the Operations Centre. The appointment of the senior fire or police official is decided by the Regional Chairman. They in turn coordinate the activities of their respective field.

Throughout our planning for the exercise we stressed to all the organizations that the Regional Chairman would appoint senior officials regardless of municipal boundaries and areas of jurisdiction. This policy was also utilized in the appointment of the Emergency Site Manager.

Lessons Learned

Exercise Boldstep was the first Regional scale exercise held in Ottawa-Carleton and many valuable lessons were learned. The exercise was a success as everyone learned something and mistakes were made and admitted, by all officials. Some of the lessons learned were;

- Plan your exercise well in advance. Unexpected problems can and do arise. Advance planning gives you the time to rectify problems.
- When dealing with a large number of organizations it is essential to plan the exercise in small groups
- establish your objectives and stick to them
- be flexible in your planning.
- don't set a rigid timetable for the exercise as invariably things will go wrong.
- utilize expert resources to provide advice, don't plan in a vacuum.
- capable, qualified personnel is the most valuable asset you have. Use them to plan your exercise.
- don't bite off more than you can chew.
- be aware of the cost factor. Exercises do cost money and advance notice is required for agencies to budget these costs. The overall cost for Exercise Boldstep was well over $75,000.
- realize that exercise planning takes time and work.

All too often emergency plans are written, approved by the agencies involved, passed as a by-law, then shelved. The Plan may appear good in theory but not testing it may result in gaps, errors, inconsistencies to go undetected. Exercise Boldstep resulted in changes to the Regional Emergency Plan, changes that we did not anticipate.

"BUILDING RESOURCES FOR HAZ-MAT RESPONSE"

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Environment Canada

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ABSTRACT

This paper describes systems in place, methods and information for guidance in building emergency response teams in Canada for hazardous material (haz-mat) incidents. Specialist response teams of hands-on experts, the initial responders in a community, and other types of chemical spill response are all considered. These groups are examined in terms of their different approaches, common needs, and possible solutions for acquiring and supplementing the resources required in order to deal effectively with haz-mat emergencies.

INTRODUCTION

In Canada, there are approximately 10,000 spills per year of oils, fuels, chemicals, and hazardous wastes, as well as other products which are environmentally toxic. Many of these incidents involve significant quantities or levels of hazard, posing risks to public health or safety, to property or the environment. Under such circumstances, special teams, countermeasures equipment and procedures are called for, involving personnel, equipment and materials which have been selected and prepared for this type of work. These are the hazardous materials emergency response teams, or "haz-mat" teams. Team development in terms of strategies, methods, and resources is the subject of this paper.

Types of Haz-Mat Teams

There are basically three types of teams which can be categorized according to their function or type of responsibilities, their levels of specialized knowledge, training and equipment, and their sources and methods of resource acquisition.

1) Specialist, Hands-On Response Teams These are primarily the teams developed by major chemical producers, by specialty contractors and by the fire departments of several large cities in Canada as well as some smaller municipalities where there are major chemical production facilities or transportation corridors. Development of this type of team requires a significant investment in personnel training, equipment and special operating procedures, and represents the largest step as well as the final step in the evolutionary development from near-site haz-mat spill monitors or advisors, through the initial responders team with its limited on-site role, to the

fully-involved, final-solution team which eventually stabilizes and terminates the serious emergency situation.

2) Initial Response Teams These teams are normally found in the fire service, or as a combination of emergency service agencies of a municipality. Their training level includes hazardous materials awareness, and tactics for sizing up and stabilizing the situation, and making rescues when safe to do so, and then waiting or evacuating until the specialist help of the material shipper or a qualified hands-on response team has arrived to resolve the situation.

3) Technical Advisory Teams Both government agencies and industries may provide this type of team to advise the On-Scene Commander (O.S.C. or site emergency manager) during the incident. Knowledge and recommendations of team members may focus on any or all of the following:

- material properties/behaviour
- handling, transfer & storage
- countermeasures equip. & techniques
- protection priorities
- environmental sensitivities
- precautions/safety
- cleanup/decontamination
- waste disposal

Members of this team will have in-depth training in their specialty, as well as hazardous materials awareness and introductory response training, but do not normally have the responsibilities, equipment or ongoing training necessary to conduct a hands-on response.

Focus on Team Resource Building

Building the capabilities of the Hands On Team is a different and significantly greater challenge than that of establishing an Initial Response Team or a Technical Advisory Team, although difficulties exist at all levels. Consequently, we will address all three types of team, but will concentrate more attention on building the resources of the Hands-On Team.

Common Factors in Building Resources

Common to the formation of all team types is the initiating mechanism or spark, inevitably a recognition of the need for a team. This spark may arise from worker's safety concerns, from management foresight, or public or political pressure. Very often, however, the need is recognized only after a significant accident has forced people to realize that major spills can happen to them, or can affect their community, their safety, their environment. Once the need has been identified, the concept of a response team emerges as part of the solution, along with increased measures for future prevention of such accidents, and contingency plans for response.

The second common factor, essential for any response team's formation and operation is management support. Passive or mild support may permit aggressive, innovative personnel the permission they need to get the team started; active management support, or even management directives and monitoring of progress are more helpful, since such initiatives and interest establish a sufficiently high level in everyone's priorites list so that time and resources are allocated promptly as needed. Without any support, a team will struggle constantly, until the next accident happens.

The third common ingredient is team member commitment and interest. For Hands-On Haz-Mat Response Teams in the fire service, the members are usually selected from the volunteers who step forward for such special duty. In many instances, an initial reluctance to volunteer has changed to a back-log of available candidates as the haz-mat program develops and as firefighters begin to recognize the merits, challenges and recognition that can accompany participation as a haz-mat team member. Of course, team members must have the appropriate background or experience to meet initial qualification, before undertaking special Haz Mat training. For industrial Hands-On Response Teams, for the Initial Response Teams, and for the Technical Advisor Teams, the participants are selected more because of their assigned duties, training and education or specialized knowledge rather than their willingness to get involved. We should stress however, that no one on any type of Haz-Mat Team should ever become a team member unwillingly. The dedication and sacrifices in time and effort, especially for the Hands-On Team, are too substantial and too important to be left to reluctant participants.

The last element common in name for all types of team, but different in specifics is team resources. All types of haz-mat team need funding or other methods for resource acquisition. All teams require some special equipment, materials and organized systems as well as reference sources, contacts and technical information. All members must develop and follow contingency plans and conduct exercises. Most importantly, team members must undergo adequate haz-mat training, in order that all other resources are used safely and effectively.

INDUSTRY RESPONSES, RESOURCES AND INITIATIVES

Industry Response Teams

In the chemical industry and associated process industries, major chemical producers have established and maintained for many years, a number of hands-on response teams. These teams are primarily intended to deal with in-plant and transportation spills of their own company products as part of company commitments to safety and to product stewardship. Many of these companies also participate in mutual aid arrangements. An example is the Transportation Emergency Assistance Plan (TEAP) of the Canadian Chemical Producers' Association (CCPA).

The TEAP plan relies on mutual-aid assistance from a TEAP member's closest Regional Response Centre. Provision of Technical Advisors, or hands-on assistance under certain circumstances, is made. This assistance continues for up to 24 hours until the requesting member or shipper can respond with his own hands-on response team. An extension of this concept of Regional Response Centres is being currently examined by the CCPA-TEAP Committee. This extension would involve Voluntary Response Centres, where CCPA member companies may choose to respond to spills of products familiar to their response personnel.

Other chemical specialty companies or associations also fund their own mutual-aid response teams and recover costs of response from the polluter or requesting agency. Among these response plans are the Chlorine Emergency Plan (CHLOREP), the Propane Gas Association of Canada (PGAC) Plan, and the Phosphorus Emergency Response Team Plan (PERT).

Industry response teams are funded by their own companies, and are reimbursed for the cost of mutual aid responses by the requesting company having the problem. These teams also welcome the opportunity to display their equipment and to exchange ideas and lessons learned with other interested parties and prospective response team organizations.

Chemical Industry Initiatives - CAER and TRANS-CAER

Under an industry-wide policy of "Responsible Care" endorsed and committed to by the CEO's of all member companies of CCPA, two programs for improving accident prevention and preparedness are underway in Canada. These programs are called "CAER" (Community Awareness and Emergency Response) for fixed plant facilities, and "TRANS-CAER" for a similar program for transportation routes and systems. These programs are an effective method for stimulating improved emergency response at the local level and in the regions.

The programs involve the cooperative assessment, prevention and response planning for chemical accidents by the local chemical industry, major transportation companies, elected and municipal officials, emergency agencies, public interest groups, and the media. The work of such diverse committees at the local or regional level goes directly toward addressing those common factors in building resources mentioned in the introduction. Evolving from the work are:

- recognition of the need for haz-mat response;
- development of management support in both local industry and the community;
- stimulation of participant commitment and interest; and
- funding and acquisition of emergency resources.

Example CAER Project - United Counties of Leeds & Grenville

In eastern Ontario, the United Counties of Leeds and Grenville have become more active in emergency preparedness in the last few years. The area includes several chemical plants and other industrial facilities, plus major highway and rail routes carrying heavy traffic loads of hazardous materials. It is also bounded by the St-Lawrence River and Seaway with its haz-mat cargo traffic, and lies adjacent to New York State, U.S.A.

A workshop for local elected officials and emergency agencies was organized in January, 1986 by Dupont Canada Inc. to stimulate the CAER process in the area. An integrated emergency exercise involving chemicals was conducted in 1987, at which many lessons were learned and many participants sensitized to the need for more comprehensive emergency preparedness.

A new Advisory Emergency Planning Committee is now addressing the general emergency response needs and mutual aid arrangements to ensure adequate resource sharing, emergency alerting and communications within the United Counties. As a result of the CAER stimulus and other regional initiatives, there are now increased levels of haz-mat training, improvements in communications equipment and in emergency procedures. Previous emergency gaps and problems are being addressed. A new haz-mat response team has been formed in the area's largest municipality, with chemical suits donated and additional funds identified for emergency response education in the area. Organizations which were formerly independent are working more closely together, and all participants are more aware of the need for dialogue and good communications.

Chemical Referral Centre

The Canadian Chemical Producers' Association has also established a national toll-free telephone service to refer callers to product experts in the Canadian chemical industry. The day-time service is not intended to handle emergency calls, but will refer such calls to the appropriate agencies, such as CANUTEC, the federal governments' emergency centre for dangerous goods information. That centre is operated by Transport Canada. The Chemical Referral Centre is, however, another information resource for possible assistance to haz-mat response teams during their contingency planning for specific chemical emergencies.

GOVERNMENTS' RESPONSES, RESOURCES AND INITIATIVES

Emergency Information and Technical Services

Most spill reporting and initial government advice for companies experiencing spills in Canada is handled at the provincial government level. These centres have technical information not available at the local police or fire-service level. As an example, the Spills Action Centre of the Ontario Ministry of the Environment receives spill reports and arranges for site visits by government advisors who will monitor the operations and provide technical guidance to the spiller as well as to the local officials.

The Federal government also operates such 24 hour centres for emergency reporting and information. As mentioned above, the DOT CANUTEC centre can provide requesting parties such as fire chiefs or haz-mat response teams with spill reporting assistance and technical guidance, as well as 24 hour contacts for other government and industry emergency personnel.

The Canadian Coast Guard operates 24 hour spill reporting centres in Coastal areas, including one-call reporting to all agencies in the Atlantic provinces. The Coast Guard also monitors, and, if necessary, provides hands-on response to marine spills from vessels in Canadian waters, although most of its response equipment is primarily suited to oil and petroleum fuel spills. They are currently reviewing the hazardous material spill situation and their potential response roles.

Environment Canada (DOE) provides 24 hour assistance in environmental and technical matters relating to chemical spills, through their regional offices and the National Environmental Emergencies Centre. Environment Canada also maintains an internationally recognized centre of excellence for spill research and technology development. A wide variety of technical reports, seminars, newsletters, prototype equipment and technical expertise is available from this Environmental Emergencies Technology Group. On major hazardous materials incidents involving difficult or ongoing technical problems, technical staff from the centre may travel to the site to provide additional support to the environmental and technical advisory teams coordinated by DOE's regional offices.

Joint Emergency Preparedness Program (JEPP) Funding

Of great interest to all haz-mat response teams are the possible sources of funding within and beyond the local or regional level. Industrial haz-mat teams must continue to seek their funding in the private sector and from other local sources such as various donors, mutual aid budgets, etc. However, local Initial Response Teams and Hands-On Response Teams involving the fire service or other municipal agency, have another significant source of potential funding for special equipment, response vehicles and protective clothing. That source is a program called JEPP, the Joint Emergency Preparedness Program. Through JEPP, the federal and provincial governments have established a system for financial support of measures designed to improve emeregency preparedness across Canada. The program is administered by Emergency Preparedness Canada with participation and joint funding coming from the provincial and territorial governments. Contacts for participation in JEPP by haz-mat response teams are the provincial/territorial government emergency measures agencies. They can provide information on application procedures and can address the possibility of the necessary provincial and federal funding.

Among the relevant projects receiving approval for JEPP funding in the past few years are:

- local/regional emergency communications systems
- regional or provincial emergency readiness planning
- emergency operations centres
- mobile command centres
- haz-mat mobile monitoring units/equipment
- haz-mat emergency response/control vehicles
- compressor systems
- training for hands-on response teams
- haz-mat emergency exercises
- sets of chemical protective clothing
- emergency response training facilities

Major Industrial Accident Coordinating Committee (MIACC)

Following the Bhopal, India chemical accident in December 1984, the federal government initiated an in-depth review by a group of experts from federal and provincial government agencies, and the chemical and petroleum industries. Additional input came from public interest groups, and other concerned parties. The resulting report made twenty one recommendations to improve the prevention of and response to such accidents in Canada. Another broader group was established to follow-up on those recommendations, a group which added participants from Universities, labour, associations for municipal governments and emergency services, and other industrial associations. This follow-up group, called "MIACC", is a potential source of information, stimulation and support for haz-mat response teams. The national group has established thirteen study groups on specific topics, including one to encourage the establishment of regional or provincial MIACC's for continuity and greater focus on regional problems and solutions. The first such regional group, called MIACC-A, has been established in Alberta and others should follow shortly. The list of national MIACC work group topics of primary interest to haz-mat response teams include:

- risk assessment for municipalities
- emergency responders' training standards
- contingency planning guidelines for municipalities
- lessons from accidents/accident trend analysis
- contingency planning guidelines for industry
- coordination of awareness material
- regionalization of MIACC
- legislation re accident prevention/response
- integration of industrial and municipal activities.

BUILDING YOUR TEAM'S RESOURCES ("BE RESOURCEFUL")

Aside from the information sources and support mechanisms presented up to now or found in the references which follow this paper, there are several sources of resources which other haz-mat teams have found helpful in building their capabilities.

Sources of Management/Public Support ("BE PERSUASIVE")

- budget justification reports
- hazard identification/analysis
- local scenario development using actual incidents
- insurance company analyses
- response team exercises/drills
- public displays/demonstrations

- public speaking opportunities
- built-up credibility w/local industry & public
- stimulation of media interest/support
- involvement of interested/concerned parties
- cooperation among agencies by persuasion

Sources of Funds ("BE PERSISTENT")

- fire service budgets
- other local/regional government budgets
- regional health authorities budgets
- emergency measures agencies
- local industrial associations
- chemical companies donations/joint ventures
- sub-contracted studies in exchange for funding
- local public service clubs projects
- donation request letters to all local HM user companies
- cost recovery request letters to spillers
- "fire-buff" club fund-raising
- "special" needs identified in Impact Assessments
- haz-mat facility/transportation inspection fees
- specific local fee or levy approved by voters
- surcharges on haz-mat shipments
- one-time grants from government agencies
- public speaking or training honoraria
- public fund drives
- local cable telethons

Sources of equipment and materials ("BE OPEN-MINDED")

- surplus/out-of-service vehicles (step vans, flat beds)
- beverage company donations (beer/pop trucks)
- insurance company donations
- local/regional chemical company donations
- regional trailer suppliers
- manufacturers of rubber/wooden/other materials
- tool manufacturers/suppliers
- welding and machine shops
- transportation companies (training equipment)
- "build-your-own" shops with industry guidance
- leasing company donations
- long or short-term loans from local plants/facilities
- loans under mutual aid agreements
- lists of available equipment available from others/contacts
- barter/exchange agreements of services for equipment or materials
- salvaged/rebuilt equipment

Sources of emergency response training ("BE NON-COMPLACENT")

- other local/regional haz-mat teams
- provincial fire marshal's office
- provincial emergency measures agencies
- provincial or federal environment agencies
- local major chemical companies/associations
- federal emergency preparedness college
- suppliers of response equipment/protective clothing
- use of local/vacant buildings/facilities

- haz-mat team interchanges
- industry guest instructors
- haz-mat training resource centres
- joint exercises with other teams

Sources of technical information ("BE THIRSTY FOR KNOWLEDGE")

- other haz-mat teams
- response team workshops
- annual seminars & conferences
- text books
- newsletters
- response manuals
- government agency reports
- periodicals and journals
- computer bulletin boards (BBS)
- response team association memberships

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EMERGENCY PREPAREDNESS - THE MISSING FACTOR IN RISK ASSESSMENT

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ABSTRACT

Starting from news reports of a highly publicized dangerous goods incident, this paper examines the paradox where a community is aware and alarmed that it is faced by an existing and continuing hazard, yet concentrates on a strategy of seeking ultimate removal of the source of the hazard while doing nothing to prepare for the emergency if one arises in the meantime. The paradox is shown to be a consequence of the way in which risk assessment studies are conducted and their conclusions reported. This paper suggests that, to overcome this, such studies must place greater emphasis on the effect of preparedness and response in mitigating the potential damage that may result from an emergency, and indicates how this effect can be quantified for use in risk analysis models.

1. INTRODUCTION

Two things were clear from the heavy media coverage which followed the PCB release at the St. Basile, Quebec, warehouse fire in August 1988.[*]

First, the citizens had been concerned about the risk of PCBs in their midst for a long time.[1] "PCB storage has terrified the town for years" read one headline. "Like a bomb waiting to go off for a long time" claimed an oil refinery worker, who was presumably more aware than the average citizen about the risk involved. The St. Basile councillor who spotted the fire while jogging said: "Residents have fought to have the storage site removed for years" - remarks which were echoed by the area's MLA,[**] who had campaigned on an environmental platform.

The second point was that, despite all this, the community was far from ready for the emergency when it happened. According to one report, "Worst of all, no emergency plan to fight such a disaster seemed to exist." The mayor was out of the country on vacation at the time of the fire. At a news conference after his return, he claimed that "the town had an emergency plan which was followed" - though apparently, this was only a general plan and was not designed to cope with such an event, despite a known hazard in the community! Another news article said that, at the news conference, the mayor evaded further questions on the contingency plan issue.

Media attention also focused on Smithville, Ontario, said to be "home to Canada's largest stockpile of PCBs." This was well known to activists from many of the country's leading environmental public interest groups, who were frequently quoted during the next few days as plans to clean up the PCBs were discussed. Smithville was also home to some of the activists, as one of the authors of this paper had found from informal discussions with two of them at a conference a few months previously.

[*] For more information on this incident, refer to the paper by André Tremblay included in these proceedings.

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Yet, Smithville fared little better than St. Basile according to the media, which reported that the town was "not prepared at all" for a similar fire and evacuation. The mayor of West Lincoln Township, which encompasses Smithville, said: "We don't have an emergency plan at all and that's been a real worry for me."

How can this be? How can a community be well aware of the risks it faces, yet do almost nothing to prepare for them? To answer these questions, and to understand what must be done to avoid this situation, one must examine how the risks of such incidents are assessed, and how decisions are made on what to do about them. An in-depth investigation is needed into how risk studies are conducted, and what they are supposed to achieve.

2. THE PROBLEM

Risk assessment studies help to:

- understand the nature of hazards and their contributing factors, and
- make balanced, informed decisions on the actions needed to reduce the risks of these to an acceptable level.

It should be noted that the term "hazard" refers to a combination of events leading to an undesired consequence, and "risk" consists of the hazard multiplied by the probability of its occurrence.

Such studies are done using different approaches depending on the specific purpose, but generally involve the following six-step process:

(i) Analysis of the total risk for the identification of the contributing factors

This step involves applying logic and experience to understand how a hazard is caused, i.e., how potential combinations of events can lead to undesired consequences. For formal studies, these relationships may be expressed as a model to assist the users with the next step. An example of such a model showing the relationships involved in the risks resulting from the transportation of dangerous goods is shown in Figure 1.[2]

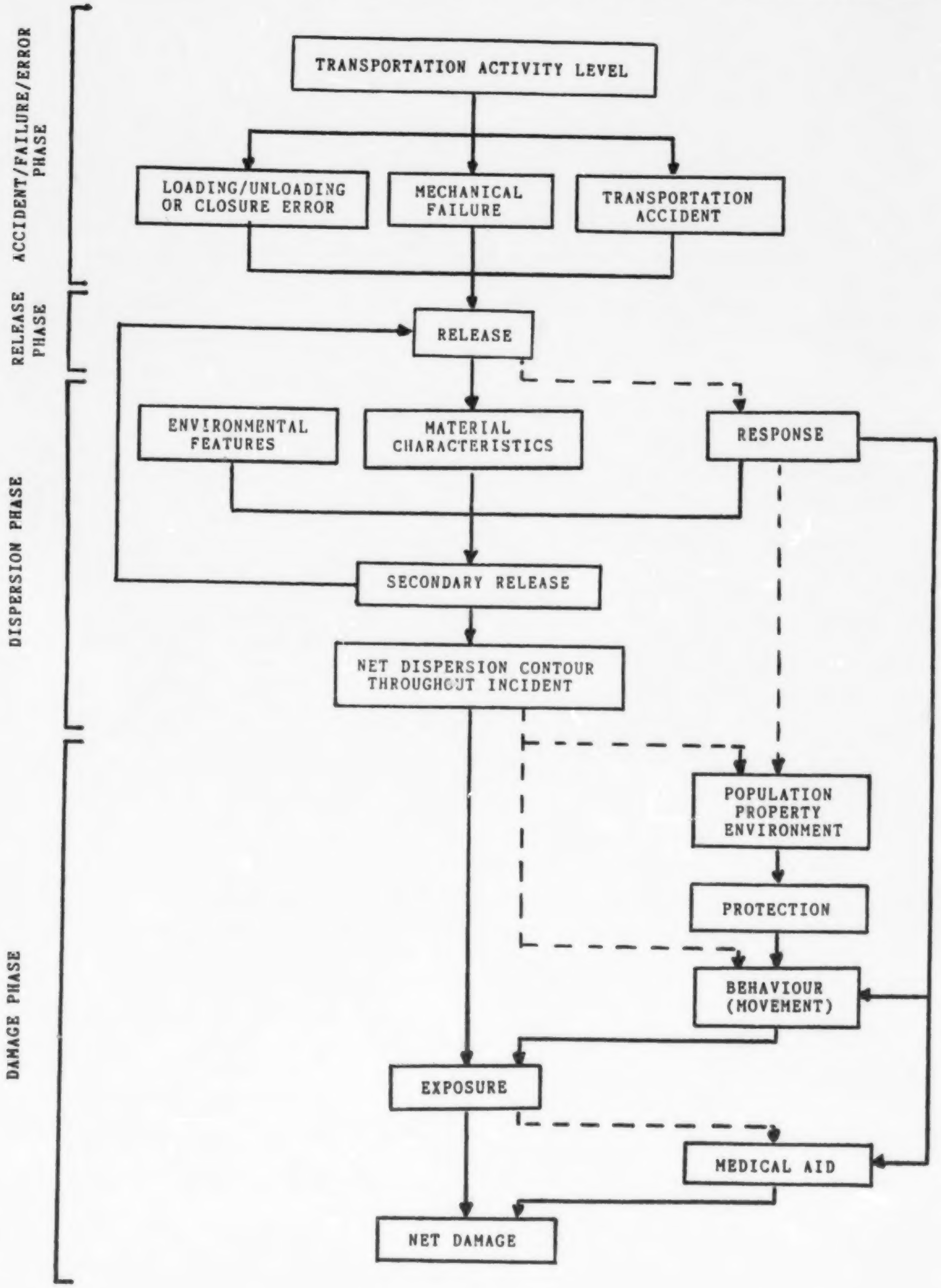
(ii) Determination of the significance of contributing factors and hence the overall risk

Here, the analysis of the factors and relationships between them is extended to estimating the probability of each combination or sequence occurring. If a factor was missed in the preceding step, it will not be given a probability here. In any case, this step also involves judgement and experience, because not all the necessary facts may be known and some assumptions will be made. Nonetheless, in principle the risk of any combination or sequence can be expressed by the risk equation:

Risk = Probability x Consequence

If the initial activity is presented as a function of time, ie., total quantity of dangerous goods transported per year, the risk can be similarly expressed, ie., fatalities, injuries or damage per year expected from that

FIGURE 1. RISK MODEL FOR TRANSPORTATION OF DANGEROUS GOODS


ACCIDENT/FAILURE/ERROR PHASE
RELEASE PHASE
DISPERSION PHASE
DAMAGE PHASE
TRANSPORTATION ACTIVITY LEVEL
LOADING/UNLOADING OR CLOSURE ERROR
MECHANICAL FAILURE
TRANSPORTATION ACCIDENT
RELEASE
ENVIRONMENTAL FEATURES
MATERIAL CHARACTERISTICS
RESPONSE
SECONDARY RELEASE
NET DISPERSION CONTOUR THROUGHOUT INCIDENT
POPULATION PROPERTY ENVIRONMENT
PROTECTION
BEHAVIOUR (MOVEMENT)
EXPOSURE
MEDICAL AID
NET DAMAGE

activity. This enables a comparison of the overall risk with that from other activities, so that its significance can be assessed. It also enables the comparison of risk levels between alternative courses of action.

(iii) Focusing attention on predominant factors

In this step, those factors having the greatest effect on the overall risk are highlighted, so that the information from the previous two steps is communicated to those affected and to the decision makers. These two groups may or may not overlap.

(iv) Identification of possible corrective actions

From an understanding of the causes of the risk one can identify the actions that can be taken to correct them. Note that although these may focus on the most significant factors, more information is needed before a clear decision can be made on the actions to be taken. This is the next step.

(v) Estimation of the resources required

For each corrective action, the resources needed - time, effort and money - for implementation must be determined. Apart from the major factors there may be some minor ones which need minimum resources to accomplish, and are therefore considered worthwhile activities.

(vi) Deciding on the most resource-effective action plan for achieving the desired level of protection for the acceptable level of resources expended

This is where a balanced decision is made between, on the one hand, absolute protection at the cost of infinite resources, and on the other, no protection at minimal effort or expense. It may also be decided, of course, that more information is needed, and that a further study should be commissioned. This has the disadvantage of effort and expense for no reduction in risk, but is presumably offset by the hope of a more effective action plan once the additional information from the study is obtained.

Returning to the question of how a community can be well aware of a risk facing it, yet be completely unprepared for an emergency when it happens: it seems that either the community knowingly chose an action plan which left it completely exposed to the very risk it feared, or else that something went seriously wrong with the process just described.

It should be pointed out here that whether formal risk studies were commissioned by the communities in question is immaterial. As has been seen, they were well aware of what they saw as a potential hazard in their midst, and the situation was one which has been studied on many occasions elsewhere. A large body of knowledge exists on the factors involved, and some of those concerned were surely aware that the risk could have been significantly reduced by measures which are a standard part of good emergency planning. In other words, much of the information in steps (i) and (ii) was already available in general form, at least to the point where the situation described could have been avoided.

The problem lies at step (iii) - the failure to focus attention on the predominant factors. These communities focused on the initial source of the problem - the actual presence of undesired materials in their midst - and chose a strategy directed solely at the removal of the source of the risk. On the surface this is an appealing option, and it is one which should certainly be considered in any such exercise. But, what happened here illustrates the danger of leaping straight to step (vi) and deciding on the action plan before fully evaluating the situation.

The result was a strategy which needed vast resources in effort and time of those at risk, while other options which could have greatly reduced the overall risk were overlooked or ignored. This is particularly the case with emergency preparedness, which could have minimized the exposure of the population once the alarm was sounded, and may have reduced the risk at the damage, dispersion and possibly release phases as well. It should also be recognized here that preparedness does not necessarily mean acquiring many additional resources, but rather organizing what there is to achieve optimum effectiveness and efficiency.

It is ironic that this was overlooked, because here in Canada not only do municipalities - and the public - have the opportunity and indeed the responsibility to protect themselves by preparing for emergencies - they are indeed the primary ones actually having the capability to do this. In fact, the inference from this can be summarized in three statements:

(a) municipalities - and the public often do not realize that they have an important influence on risk;
(b) municipalities - and the public - do not realize that they have a responsibility for preparedness; and,
(c) because the out-of-pocket costs of improved preparedness are more noticeable than the largely hidden costs of inaction, preparedness measures are often difficult to justify.

Yet, one cannot entirely blame the communities or their unfortunate residents, for the fault is not theirs alone. It seems more likely that they acted in good faith, but on flawed information. They did not fully understand or realize the situation because their attention, though aroused, was focused on only part of the problem. The reason for this lies, it is suggested, in the way in which the risk and its underlying factors were communicated to those involved. In such situations, extra care must be taken to ensure that people fully understand the implications of their chosen strategy.

3. WHAT IS NEEDED

To avoid this situation, risk studies should tell the whole story and not just part of it. If comments are directed to the risk posed by, for example, hazardous materials in the community, it should also be shown how these risks can be affected by the state of emergency preparedness.

Risk studies help to gain greater understanding of the nature of risk and hence of what can be done to reduce it - but the findings must be applied with care if they are to be fully effective. Alerting people so that they demand that something be done is of little use and can even be counterproductive if through getting half the story they go off in the wrong direction. The news media have a strong tendency to seize upon attention-getting worst-case scenarios, and often encourage confrontational attempts by citizens and interest groups to get the source of the risk removed. To ensure that people hear and understand all the facts may mean that other relevant aspects must be emphasized as well.

If this is not done, the opportunity to provide true service to those affected by the study will be lost. Furthermore, tacit acceptance of biased study reports which ignore the effect of emergency preparedness is immaterial, i.e., it makes no difference whether it is improved or not.

Including a full treatment of emergency preparedness in risk studies, however, means that first some means must be found to categorize preparedness and quantify its effect. This perhaps is one of the reasons why the problem exists, because risk studies involve a great deal of time and effort, and therefore tend to build on accumulated techniques and data from earlier investigations - and with preparedness, much of this either does not exist in quantified form or is not readily available.

The next step, therefore, is to suggest an approach which can be used as a framework for developing a preparedness model.

4. AN EMERGENCY PREPAREDNESS MODEL

In this approach for modelling the emergency preparedness component of a risk study, there are five basic steps:

(i) determination of scope of risks involved in study,
(ii) identification of mitigating factors for preparedness and response;
(iii) generation of matrix of factors and degree of preparedness;
(iv) assigning of numerical values, weighted as appropriate for effect on specific community and risk; and,
(v) incorporation into main study of overall risk.

Each of these will now be examined.

(i) Determination of scope of risks involved in study

This step is necessary because the scope of the risks being considered has a major bearing on the preparedness measures which are appropriate and also on their effectiveness. For example, the ability to use booms to control oil releases on water is likely to be much more significant for a study involving environmental risk to wildlife and property than if it is restricted to effects on human life. In a non-hazmat example, the availability of boats may be very significant when studying total risk in an area vulnerable to flooding, though this factor is of little interest if the study deals only with land-based hazards. The scope, then, should correspond to the nature and scale of risks considered in the main study.

(ii) Identification of mitigating factors for preparedness and response

Once the scope of the risks is known, these can be examined and a list of mitigating factors compiled. Simple examples of these were given above. Here it is useful to identify first the main categories, such as fire, police, emergency medical services, etc. This may become quite extensive depending on the scope of the main study, but the list does not need to include every category of response service. A list of some of the categories to consider is given in Table 1.

TABLE 1: CATEGORIES FOR ASSESSMENT OF EMERGENCY RESPONSE CAPABILITY[3]

Local government
Emergency measures organizations
Fire / rescue services
Police
Ambulance / medical / coroner / emergency health services
Engineering
Utilities
Welfare / social services / volunteer agencies
Transportation
Contractors
Industry specialists
Airports and airlines
Communications / radio stations / amateur radio
Suppliers
Radiac
Coast guard / Port authority / Seaway authority
Environmental agencies

It is important to remember that this exercise is useful only insofar as it affects the basic risks identified in the main study. If a factor is a part of a potential response but has only a small effect on the damage suffered, it should be ignored here.

The main categories can then be expanded as appropriate, i.e., "fire" may include the number of appliances, certain special equipment, etc. Again, this process should be carried only as far as is practical and relevant to the main study. A more detailed examination of factors as they apply to dangerous goods emergency response has been provided by Creedy.[4]

(iii) Generation of matrix factors and degree of preparedness

With the list of factors by category displayed vertically, a matrix can then be generated with columns corresponding to the degree or level of preparedness for each factor. An example of this is shown in Table 2.

The number of columns depends on the detail desired, but four are suggested. This enables significant variation in preparedness to be taken into account, and also avoids the tendency to assign mid-range values to any factors whose status in uncertain.

Standard descriptions can then be entered giving the criteria for rating each factor. It is generally easier to describe the "excellent" level first, followed by "poor", then to interpolate for the remaining levels.

(iv) Assigning numerical values, weighted as appropriate for effect on specific community and risk

This exercise would be straightforward if all factors were equally important, but this is clearly not the case. Their importance depends largely on the specific community or population exposed and on the nature of the unmitigated risk, and varies with both the type of risk and its scale. This step must therefore be repeated in a series of iterations for typical community, risk and scale characteristics. As with the level of preparedness, it is easier to start with the factor having the greatest mitigating effect. This effect should correspond to the "excellent" level of response.

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TABLE 2 ACTIVITY STANDARDS FOR EMERGENCY PREPAREDNESS AND RESPONSE (5)

Activity	Poor	Fair	Good	Excellent	Weightings
A **Organization and Administration**					P F G E
Statement of policy, responsibilities assigned, communicated and understood	No statement of policy. Responsibility and accountability not assigned	General understanding of emergency preparedness and responsibilities, but not written	Policy and responsibilties written and distributed to those concerned	Emergency preparedness policy reviewed annually and posted. Responsibilities emphasized and assessed by evaluation/audit	
Emergency plan coverage	No plan or procedures	General awareness of major risks. Basic plan exists but coverage is uneven/incomplete	Informal assessment of most risks. Plan developed to cover these, but with some areas weak or incomplete	Risks assessed and plan developed to cover all which pose a significant threat	
Extent or depth of planning	None	Plan extends to only to basic response agencies, which have some plans of their own. Critical information missing with no provision for obtaining it rapidly in emergency	Plan extends to most agencies, but some of these have not developed their own plans. Some hazard information available, but sources of missing data are not well known	Plan extends to all appropriate agencies, each of which has well developed plan of its own. Plans contain all general information for identified hazards, and procedures for obtaining more information if required	
Updating and testing	No test in the last five years	Plan occasionally updated. Tested in last five years, but by table-top or simplified field exercise for basic agencies only	Plan updated and tested within last two years, but not in full-scale exercise	Plan kept current and comprehensive test conducted during the last two years.	
Plan communication	Response agencies not fully aware. Few written instructions issued. No communication with public	Response agencies generally aware. Some communication of plan to public, but no proper written instructions publicly issued	Written instructions communicated to public, but instructions not easy to follow. No provision made for direct radio communication	Clear written instructions issued to all residences, institutions, etc. in area, with provision for direct radio communication	
Direct involvement of authorities	No visible commitment or lip service only	Authorities show some intent to prepare, but priority is low and resources insufficient	Authorities try to be prepared, but commitment is sporadic or uneven	Authorities serious about preparedness for emergencies. Strong support and commitment from top down	
Hazard control	Enforcement of regulations extremely lax or non-existent. No real attempt at hazard education	Some inspection and enforcement in high-visibility risk areas, but control is weak. Little hazard education	Inspection and enforcement done, but with some inconsistencies. Education for some unregulated hazards	Close monitoring, inspection and enforcement of regulations by appropriate agencies, with education to cover hazards not specifically regulated	
Incident investigation	None, other than where required by outside authorities	Occasional investigation of major incidents, with partial corrective action for major deficiencies only	Investigation of many incidents with some corrective action, but follow-up is uneven or sporadic	Investigation of all significant incidents and near-misses with serious potential, with corrective action and follow-up as appropriate	
B **Resources**	Note: Complete sections B and C	as appropriate for each agency or	service listed in Table 1		
Availability of human resources	Minimal personnel, mostly on volunteer or part-time basis	Some full-time personnel in major response agencies, but most are at non-professional level. Few reserves	Full-time personnel including professionals and some specialists in many agencies, but with some gaps or limited reserves	Adequate personnel including full-time professionals, with reserves available and specialists where appropriate	
Level of skills	Knowledge and experience weak, with no specialized training	Either competence or motivation weak. Basic training and experience with little updating and few specialized skills. May not recognize some hazardous situations	Average competence and motivation, with training in most fields and moderate updating. Some specialized skills. Able to recognize where expert aid should be sought	Personnel highly competent and motivated, with up-to-date training, knowledge and experience in all appropriate fields including specialized disciplines	
Emergency equipment and facilities	Facilities and equipment at minimum serviceable level	Facilities and equipment partly available, with some critical items missing or poorly maintained. Little special equipment	Facilities and equipment including special items generally existing, but occasionally missing or out of service.	Adequate, well-maintained facilities and equipment for typical hazards, plus special equipment where appropriate for identified hazards	
Emergency supplies	Available supplies insufficient, with no provision for rapid deployment. No arrangements for reserve supplies	Basic supplies only on hand, with availability of reserve supplies low or questionable	Supplies mostly available, but some shortages or lack of reserves	Adequate supplies readily available for rapid use, with backup arrangements if reserve supplies needed	
C **Response Time and Effectiveness**					
Alerting capability	Poor emergency alerting system for responders, with no effective alerting system for public	Basic alerting system exists, but effectiveness for public alert is low or time-consuming	Good alerting system covers most areas, but with some gaps or delay	Provision for effective, rapid alerting of any affected area in the community	
Access	Very limited or difficult access to scene and out, or access likely to be seriously obstructed during actual emergency	Access routes exist, but movement in emergency is likely to be difficult, especially for responders approaching scene	Access generally good, but routes and traffic could cause some delays	Routes and traffic control measures permit prompt access to scene for responders and equipment, and rapid evacuation of casualties and public	
Situation assessment	Assessment difficult due to information unavailable, confusing or misleading	Information on situation can be obtained, but is delayed, incomplete or difficult to interpret	Information on situation can be obtained with minor delay or uncertainty	Responders able to get needed incident-specific information quickly and accurately to form accurate assessment of situation	
Decision-making	Decision-making likely to be difficult or poor, with confused communication to responders	Making and communication of decisions sufficient for basic problems, but may be slow, partially in error	Decision-making likely to be basically sound, but with some error or faulty communication	Command control organization enables effective, rapid decision-making and communication to appropriate response personnel	
Response implementation	Implementation difficult and/or very slow, possibly even making situation worse	Selected response measures implemented with significant delay or loss of effectiveness	Selected response measures implemented, but with some delay or loss of effectiveness	Response measures selected can be implemented effectively and rapidly	

Note: Factors given under Section A influence risk by affecting the probability of an initial incident occurring. Those in Sections B and C refer more to the effect of response measures once an incident has started.

Weighting factor values are then assigned using a scale where zero indicates that a particular response characteristic has no effect on the emergency, while unity indicates that complete mitigation occurs. This can be expressed by the equation:

$$E' = E \times (1 - R)$$

- where E' is the effect of the emergency after the response
- E is the unmitigated effect (in the absence of any response)
- R is the mitigation as a result of the response

Consider, for example, an emergency involving leakage of dangerous goods from a tanker, where the unmitigated effect E for a given set of circumstances could be expressed in dollar terms at, say, $1,000,000. If an excellent level of response could reduce this by 60%, then R would be 0.6 giving a mitigated effect E' equal to $400,000.

Once the mitigating effect for a given factor at the "excellent" level has been estimated, intermediate values for the other levels can be assigned. These should be based on judgement, since they are not necessarily linear. A "poor" response, for example, could conceivably make the emergency far worse than no response at all, such as where untrained responders perish in a misguided attempt to stop a toxic spill without taking sufficient precautions. In such a case R would be assigned a negative number.

(v) Incorporation into main study of overall risk

The matrix values can then be incorporated into the main study in the usual way. For example, in a study of risk as a result of transporting dangerous goods along known corridors, the sections travelled could be examined for the effect of preparedness in a similar way to the examination for route conditions or population density and characteristics. Mathematical relationships for the influence of the most significant preparedness measures in mitigating base risk would be derived from judgement and an analysis of the effects of similar responses on known incidents. The study could then be run with variation of the preparedness factors from poor to excellent to check for results which are obviously out, and for sensitivity analysis.

5. CONCLUSION

Communities may be aware of the risks they face, but they need help if they are to develop effective strategies to deal with them. Risk studies can be of great value in helping to understand the nature of hazards and their contributing factors, and to make balanced, informed decisions on the actions needed to reduce the risks to acceptable levels. But studies must be conducted - and presented - with care if they are not to become simply an academic exercise, failing to achieve their basic purpose.

Emergency preparedness must be recognized as a key factor in overall risk. Including a proper treatment of emergency preparedness in risk studies, and emphasizing the results so that they are fully understood, will do much to avoid the situations described in the introduction to this paper.

A way in which this can be done has been suggested here. The results will not be exact - assumptions must be made, as indeed they are in other aspects of the study of risk. But they will show that preparedness does make a difference - and often far sooner, and at far less cost, than trying to remove the source of the risk from the community.

There is also a further benefit. By quantifying the difference preparedness can make, its importance is not only highlighted but a tool is also provided for its economic justification. Response organizations such as fire and police departments, the communities and the public themselves are enabled to see clearly the cost of inaction, thereby increasing the pressure to upgrade planning, people, training and equipment. Giving emergency preparedness its due can bring about a greater understanding by municipalities and their citizens of their own ability - and of their own responsibility - to protect themselves.

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1. Media quotes are from the Ottawa Citizen, 24, 24 and 26 August 1988.

2. Risk model for transportation of dangerous goods, from Creedy Associates, A Comparative Study of the Factors contributing to the Safety of Rail and Highway Transportation of Dangerous Goods, Transport Canada, Contract N0914, page 11, 1987.

3. Adapted from the course manual Plans and Operations Peace, Emergency Preparedness Canada, section EPC 805 , annex B, 1986.

4. Creedy, op. cit., pp. 27-35, pp. 58-70.

5. This approach is adapted from that of the British Safety Council given in Lees, F.P., Loss Prevention in the Process Industries, Butterworths, London, pp. 136-140, 1980.

TESTING THE EFFECTIVENESS OF EMERGENCY PLANNING STRATEGIES FOR REDUCING THE RISK FROM THE TRANSPORTATION OF DANGEROUS GOODS

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ABSTRACT

In Britain, the strategy of sheltering is used as one of the primary means of protecting the public against toxic gas incidents at hazardous installations. By law, the public near such installations are provided with information on what to do in an emergency; in most cases, this includes the advice to go indoors, minimise ventilation into the building and tune into a local radio station. Once the incident is over they are encouraged to leave the building as soon as possible to minimise their 'dose' of gas. Evacuation is only attempted when there is no chance that people will be caught in the open and when it is the appropriate response.

This paper reviews the historical evidence that supports sheltering as opposed to evacuation for toxic gas incidents and shows by simple mathematical modelling the measure of protection that can be achieved. The effect of ventilation rate and the duration of the time before people go outdoors after an incident are shown. Risk models currently under development in HSE could be used to examine the effectiveness of such protection strategies if proposed for the transportation of hazardous materials.

INTRODUCTION

There is a growing concern in Europe about the risks to members of the public from the transport of hazardous goods. This is leading to increased scrutiny by government regulatory authorities and calls for further controls.

In Britain, the risks from static major hazards installations were reviewed by the Advisory Committee on Major Hazards (ACMH) who produced three reports [1,2,3] containing their conclusions and suggestions for systems of control. In their last report, ACMH recognised the growing concern in Britain over the transportation of hazardous materials and suggested that many of the controls they had recommended for fixed installations could be applied to transport. They particularly raised the feasibility of comparing the risk from different modes of transport, the possibility of routeing to minimise the risk to the public and the need for good communications in the event of an accident involving a hazardous material.

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* The views expressed in this paper are the author's and do not necessarily represent those of the Health and Safety Executive.

The Health and Safety Commission (HSC) responded by setting up a sub-committee comprising nominated experts from industry, trade unions, local authorities, the emergency services and an independent academic [4].

HSE's Technology Division has constructed risk models to allow it to support the work of the committee by analysing the levels of risk from the transportation of hazardous materials and testing the effectiveness of any proposed controls.

ACMH recognised that, for static installations, it was necessary for industry to offer information to local authorities and the emergency services on the appropriate course of action for a particular situation. This policy has been adopted in Britain by the Control of Industrial Major Accident Hazard Regulations 1984 [5] which include a requirement on manufacturers in control of certain installations to provide Local Authorities with advice to enable them to prepare 'off-site' emergency plans and to inform members of the public who may be affected of the correct behaviour to adopt in the event of a major accident. For most installations, members of the public have been advised to seek shelter indoors in the event of an incident, closing windows and doors, minimising ventilation. They are advised to stay there until told to come out, in many cases by messages broadcast over a local radio station.

Emergency plans now only advocate pre-incident evacuation in limited, clearly defined circumstances where either the time before a release occurs can be predicted with confidence or certain remedial measures, such as righting a damaged tanker, can be postponed until evacuation is completed.

The benefits of sheltering and the disadvantages of evacuation as strategies for minimising the impact of a toxic gas incident on a population have been demonstrated elsewhere [6]. This approach is now generally accepted in Europe and the recent conference on 'Sheltering Inplace During Chemical Emergencies' sponsored by the US Environmental Protection Agency and the Federal Emergency Management Agency show that there is a growing acceptance in North America [7,8].

HISTORICAL EXPERIENCE AND EXPERIMENTAL RESULTS

There have been many accounts of incidents involving toxic gas releases where people indoors have survived whilst those outside have perished. Following the rupture of a tank truck containing ammonia in Houston in 1975, 178 motorists were injured and 5 killed [10]. Those motorists who tried to run away from the area suffered blindness, nausea, disorientation and choking; they were unable to return to their vehicles, many of them collapsed and had to be rescued. The gas cloud engulfed the nearby Houston Post building killing birds outside but because the ventilation system had been switched off, the 400 staff inside were unaffected [11]. The number of motorist casualties was minimised by favourable meteorological conditions and because most cars used air conditioning on recirculation.

The rupture of a 6000 gallon liquid chlorine rail car at La Barre, Louisiana on February 1, 1961 led to 100 casualties and the death of one child [12]. The child, 11 months old James Harris III was at home with his family and was exposed to the gas for about 20 minutes, 150 ft from the scene of the crash. Most of the exposure occurred inside the house, but some (possibly the critical portion) occurred when the father became frantic and carried the child outside. The six other members of the family who remained indoors, including a 2 month old child, collapsed but survived.

The account of the ammonia tank release at Potchefstroom in 1974 shows that people who left their homes 180-200m from the release perished while workers who took refuge in a building 80m away survived [13].

In 1973/74 trials were carried out in Holland on the infiltration of heavy gases into buildings [14]. Using 10 minute continuous releases of Freon 12 the trials showed that the peak concentration inside the house was roughly 1/10 the outside concentration on the windward side of the house and 1/20 on the leeward side. If steps were taken to especially seal windows and doors this could be further reduced to 1/30-1/50. The work also showed that with internal convection mixing within the home, there was little benefit to be gained from seeking shelter in upstairs rooms. Indeed for the dispersion of a dense gas the dense phase, where a cloud will hug the ground, can be relatively short compared with the distances out to which fatal concentrations could be found. In the passive phase the cloud may well be higher than a two storey house.

As part of the same series of trials, cars were run in atmospheres of chlorine up to 3% with no apparent ill effects on the engine. The workers concluded that it would be possible to drive through a chlorine cloud providing the driver was suitably protected.

THE BENEFITS OF SHELTERING

When faced with a toxic gas cloud, a person has a range of options depending on whether he is indoors or out. His survival may depend on his choice; Figure 1 shows these options, this scheme forming the basis of HSE's toxic gas risk analysis model, RISKAT [15].

To investigate the benefits from sheltering, I have used a simple gas infiltration model to calculate 'indoor' toxic loads [16]. This assumes that the concentration indoors will build up exponentially during the time the gas cloud passes the building at a rate proportional to the outside concentration and the air exchange rate for the building:

$$C(I) = C(O).(1-\exp(-\lambda.t)) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

where C(O) is the outside, 'top-hat' concentration and λ is the ventilation rate. Once the cloud has passed, the concentration indoors decays exponentially:

$$C(I) = C(max).\exp(-\lambda.t) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (2)$$

where C(max) is the maximum inside concentration. This is shown in Figure 2 for a building with one air change per hour.

It can be seen that whilst considerable protection may be afforded to persons who remain or escape indoors the highest benefit is received if people leave the building once the cloud has passed. If they remain indoors they will continue to add to their "dose" of gas.

The harmful causative effect or toxic load, TL, for a gaseous exposure is a function of both the concentration (C) and the time of exposure (t), and for a single exposure to a constant concentration it may be represented by equation (3).

$$TL = C^n \times t \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3)$$

With toxic irritant gases, such as chlorine, concentration is the dominant factor and n is greater than one. In this paper, I have used chlorine as an example and used the toxic load relationship used in HSE to describe a 'dangerous toxic load' which will result in the deaths of a few percent, the most vulnerable, of a heterogeneous human population [17]. This uses a value of $n = 2.75$ and $TL = 3.2 \times 10^6$ ppm $^{2.75}$ min.

Expression (3) is only true for constant C, it is normally assumed that for varying concentrations with time:

$$TL = \int_0^t C^n . dt \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (4)$$

Therefore, for persons indoors we can insert expressions (1) and (2) in (4) and integrate with respect to time to determine the received indoor toxic load.

I have used, for an example, a ten minute duration release with an outside concentration of 300 ppm of chlorine. This we would expect to lead to deaths in a general population within a minute. Figure 3 shows the variation in toxic load indoors for three ventilation rates for evacuation times of 1 air change per hour, Figure 4 shows the variation of indoor toxic load with evacuation time for outdoor concentrations of 100 to 1000 ppm. These results demonstrate not only the benefit from being indoors, but the need for people to leave their homes to come out into the fresh air once the cloud has passed. For three ventilation rates, Figure 5 gives the time available for the emergency services to get people outside before they accumulate a dangerous toxic load, as a function of outside concentration.

Ventilation rate

In buildings relying on natural ventilation λ will be a function of several variables including internal layout, air mixing rate, weather conditions/wind speeds, difference between internal and external temperatures, building construction and heating systems [9]. For mechanically ventilated buildings, the air mixing rate and ventilation arrangements will be the major factors contributing to the ventilation rate.

The theoretical ventilation rate λ can be reduced by a factor (K) to represent the imperfect mixing that occurs in reality. The empirical mixing factor (K) has a value of between 0 and 1 such that $K.\lambda$ = the effective ventilation rate. Environmental test chamber work has shown that K varies between 0.7 and 0.8 but with real, small rooms values as low as 0.1 may be appropriate. It is suggested that the use of $K = 0.5$ and 0.8 for natural and mechanically ventilated premises is reasonable. Using published guides for recommended air change rates it is possible to suggest effective ventilation rates for different BRITISH building types:

BUILDING TYPE	EFFECTIVE VENTILATION RATE (ACH)
Housing including blocks of flats	1.0 to 4.0*
Factories - light industrial work	3
Factories - heavy industrial involving either hot or fume producing work	5
Large Wholesale Warehouses	3
Large Retail Warehouses/DIY Centres Offices, Schools and Colleges	5
Hotels and residential homes for old and handicapped	5
Large Department stores and places of public entertainment	8
Hospitals etc	10

* In general the ventilation rate in British houses increases with the age of the building, the windspeed and the number of open windows (varies with the season and time of day). However, by closing all doors and windows most houses will have a ventilation rate of between 1 and 2 a.c.h. Only by sealing all the cracks and gaps in and around doors and windows is it possible to achieve rates of the order of 0.5 a.c.h. a value frequently attained in Northern American and Scandinavian houses in winter time [6].

Conclusions on staying indoors

Except in the case of sustained continuous release, staying or going indoors may provide substantial protection against receiving a harmful dose of toxic gas. At least 1 order of magnitude attenuation of the outdoor dose may be achieved for ventilation rates of 2 ach or less. In addition the extent of this protection is dependent on residence time after the cloud has passed. For releases resulting in outdoor concentrations of 300 ppm for 10 minutes or less people would have to remain indoors for at least an hour to receive a dangerous toxic load.

With higher ventilation rates the protection is reduced and evacuation other than immediately after the passage of the cloud is of reduced benefit. For short releases, "fatal" doses could be received indoors 10 minutes after the passage of a cloud with a relatively low concentration of 150 ppm. This stresses the importance of minimising ventilation rates in buildings by closing windows, stopping draughts and circulating systems (e.g. central heating) or switching off mechanical ventilation before the gas affects the premises, and increasing ventilation by opening windows and switching on ventilation systems or going outdoors once the cloud has passed.

Walking out of the cloud

Figure 1 includes the option that the individual might be able to walk out of the toxic gas cloud and hence minimise his toxic load. However to achieve this, the individual must know that a release has taken place and set off walking on a course at right-angles to the cloud without deviation. He must not panic but maintain an even pace to ensure that his respiration rate does not increase substantially. In reality it would be difficult to predict from which direction a cloud is coming. At ground level it would be very difficult to discern the correct direction to walk let alone maintain it across intervening properties, rivers and fences etc [18].

In all directions he is likely to encounter pockets of low and high concentrations etc, producing a misleading picture. In reality the most level-headed individual is likely to adopt a tortuous route out of the cloud receiving a dose in excess of that predicted. Additionally, a person escaping would have to cope with the severe physiological reactions found on exposure to levels of toxic gas well below those considered fatal. For example, with chlorine at 3-6 ppm [19] "Stinging and burning in the eyes, nose and throat, and perhaps head-ache due to sinus irritation. Maybe watering of the eyes, sneezing, coughing and bloody nose and/or blood-tinged sputum" and at 30 ppm "Immediate cough with choking sensation ..... possibility of nausea and vomiting". For these reasons it is naive to assume that people will behave rationally during a chlorine release emergency. For most people the circumstances of such an event will be unique in their experience and they will have no frame of reference to aid the judgement.

RISK ANALYSIS

Risk Analysis can be used to demonstrate the benefits from adopting an emergency planning strategy for hazardous goods transportation incidents that includes:

1) encouragement to the public to seek shelter immediately they detect an incident or receive a warning;

2) advice to those sheltering that significantly reduces the building ventilation rate; and,

3) a means of ensuring those sheltering are brought out into the air once the cloud has passed.

HSE has built a series of risk models that measure levels of individual and societal risk involved in a transport operation. We have sought to ensure that our models are realistic, accurate, flexible and transparent. These models are ideal, therefore, to test the effect of changes in, for example, emergency precautions in terms of changes in the levels of risk imposed on a community or society as a whole.

Risk models

Full details of the risk models HSE uses may be found elsewhere [20,21]. The impact of a transport operation on a society is best measured using societal risk. In its simplest form, the societal risk from an event can be described by two terms. The frequency of the number of fatalities from event E is:

$$f\ (N,E) = \sum_{J=1}^{n}\ (E,J)\ .\ P(J)\ .\ L(q)\ .\ Y\ \ldots\ldots\ldots\ldots\ldots\ (5)$$

where F (E,J) is the frequency of event E occurring in J weather, P(J) is the probability of the J'th weather, L(q) is the length along-side the route of population type q and Y is the number of vehicles that pass along L(q). The corresponding number of fatalities is:-

$$N (E) = \sum_{J=1}^{n} D(q) \,.\, A^{/} (E,J) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (6)$$

where D(q) is the density of the population type q, and $A^{/}$ (E,J) is the area affected by event E in weather J.

HSE uses the dense gas dispersion models CRUNCH, for continuous releases and DENZ, for instantaneous releases, directly to give the necessary areas affects (isopleths) [22,23]. However, in modelling the behaviour of a human population affected by a toxic gas cloud and the human response, a more rigourous approach than that adopted by other workers in the past is thought necessary. In consideration of the variation in individual sensitivity to toxic gases we assume that the response of a human population to chlorine follows a log-normal distribution, HSE has obtained the following probit expression:

$$Y = 0.52 \, \mathrm{Ln}C^{2.75} t - 4.4 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (7)$$

where the concentration is measured in ppm. Using dispersion models it is possible to estimate isopleth areas for Lct_{10}, Lct_{50}, and Lct_{90} toxic loads; it is assumed that a person between the Lct_X and Lct_Y isopleths will have a (X + Y)/2% chance of dying.

We also use the scheme shown in Figure 1 to allow for the mitigation produced by people going or being indoors and apply the approach described above to calculate 'indoor' toxic loads. For this work we have used ventilation rates that vary according to the type of building and the windspeed [9]. For example, for housing, we have assumed that there are 2 air changes per hour in F/2 weather and 3 in D/5.

Recent work [24] shows that for an average family car, the 'ram' effect of forward motion produces a very high rate of air exchange and hence gas ingress. At 40 mph, over one airchange a minute is produced. Even if the car is stationary, a fan operating at the lowest speed will produce a similar rate of ventilation. We have therefore assumed that motorists caught inside their vehicles during a chlorine release area afforded little protection.

CONCLUSIONS

In the event of an incident involving a release of toxic gas, staying or going indoors provides a substantial protection against short to medium term continuous and quasi-instantaneous releases.

Most people who go indoors will have a good chance of survival providing the ventilation rate is reduced as soon as possible and they go outside or increase the ventilation rate immediately after the cloud has passed.

Escape by walking out of the cloud is unlikely to be successful unless a person is at a distance from the release where his theoretical straight line cross-wind path, at walking pace, would accumulate less than a small fraction of a fatal toxic load. But at that level, he would feel little effect from the release if he stayed indoors and would be saved the inconvenience and worry involved in evacuation.

Pre-incident evacuation should only be undertaken when the time available before any release occurs can be confidently predicted and when it is advantageous to do so. Consideration should be given to the costs and disruption involved and the possibility for the evacuees being caught in the open.

Post-incident evacuation is very valuable to bring people out of their homes into the fresh air but should only be undertaken once the incident is over and there is no risk of recurrence.

In Britain, certain hazardous installations already give information to the public in the vicinity of the site advising them that if a release of toxic gas occurs, to go indoors and minimise ventilation into the building. The public are advised to choose a poorly ventilated room and to remain there until told to come out. Many emergency plans for these installations include provision for communication with the public via a local radio station so that they may be encouraged to protect themselves, remain inside their homes during the incident and enter the fresh air once the cloud has passed.

The risk models described in this paper should provide an efficient means of testing the effectiveness of protection strategies such as sheltering. They could show how, for example, the level of risk for a community through which dangerous goods travel might be changed if such measures were adopted. The results may also form a useful input to any cost benefit analysis.

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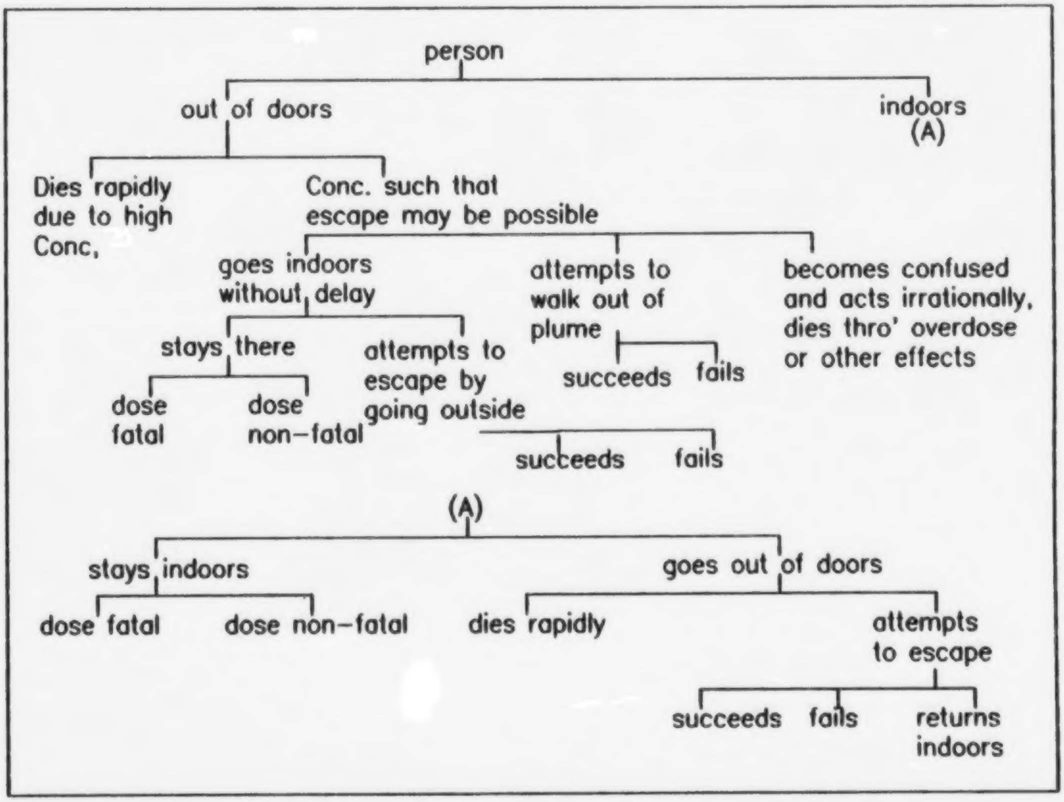
person
out of doors
indoors (A)
Dies rapidly due to high Conc,
Conc. such that escape may be possible
goes indoors without delay
attempts to walk out of plume
becomes confused and acts irrationally, dies thro' overdose or other effects
stays there
attempts to escape by going outside
succeeds
fails
dose fatal
dose non-fatal
succeeds
fails
(A)
stays indoors
goes out of doors
dose fatal
dose non-fatal
dies rapidly
attempts to escape
succeeds
fails
returns indoors

Figure 1 Range of Options Facing Person Caught in Toxic Gas Cloud

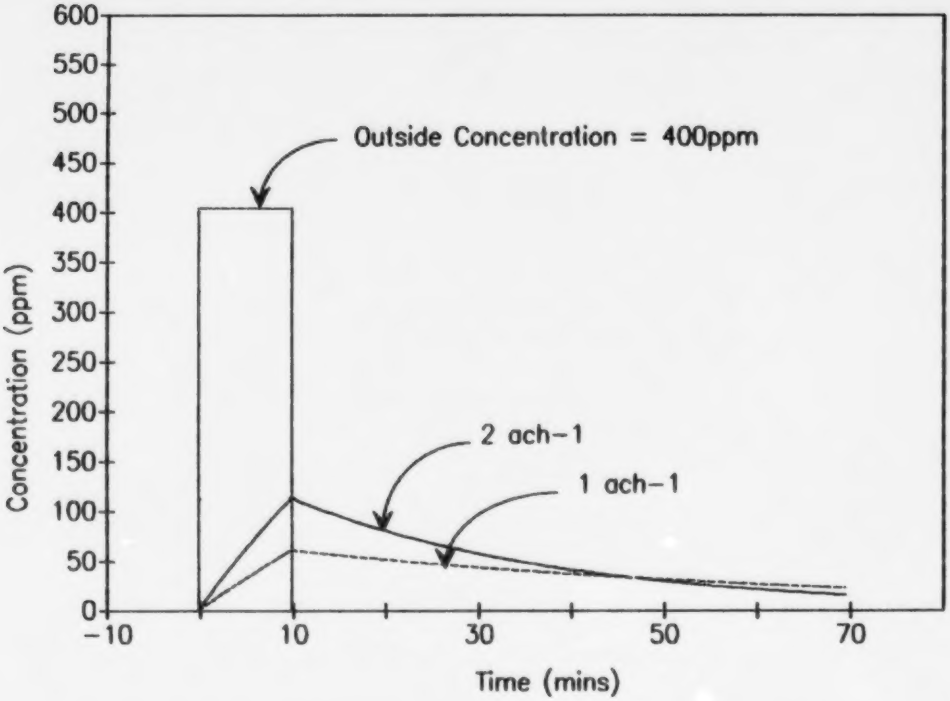

Figure 2, Results from gas infiltration model

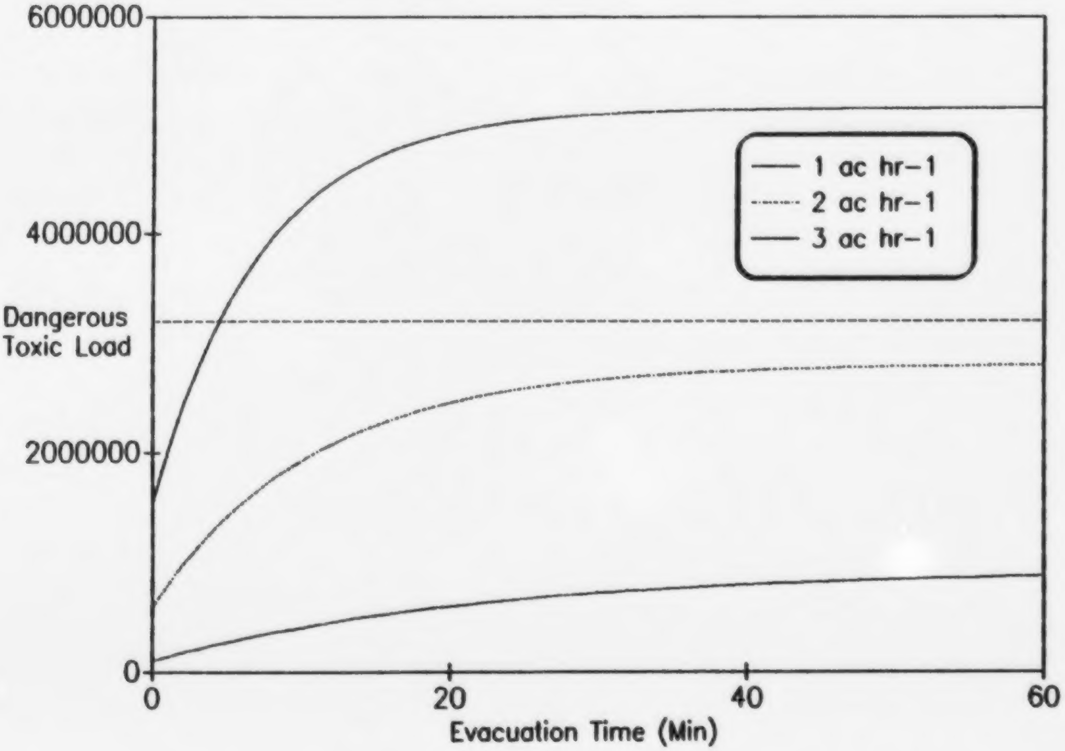

Figure 3, Indoor Toxic Loads Against Evacuation Time for a 10 min Release Giving 300ppm Out of Doors. Effect of Ventilation Rate

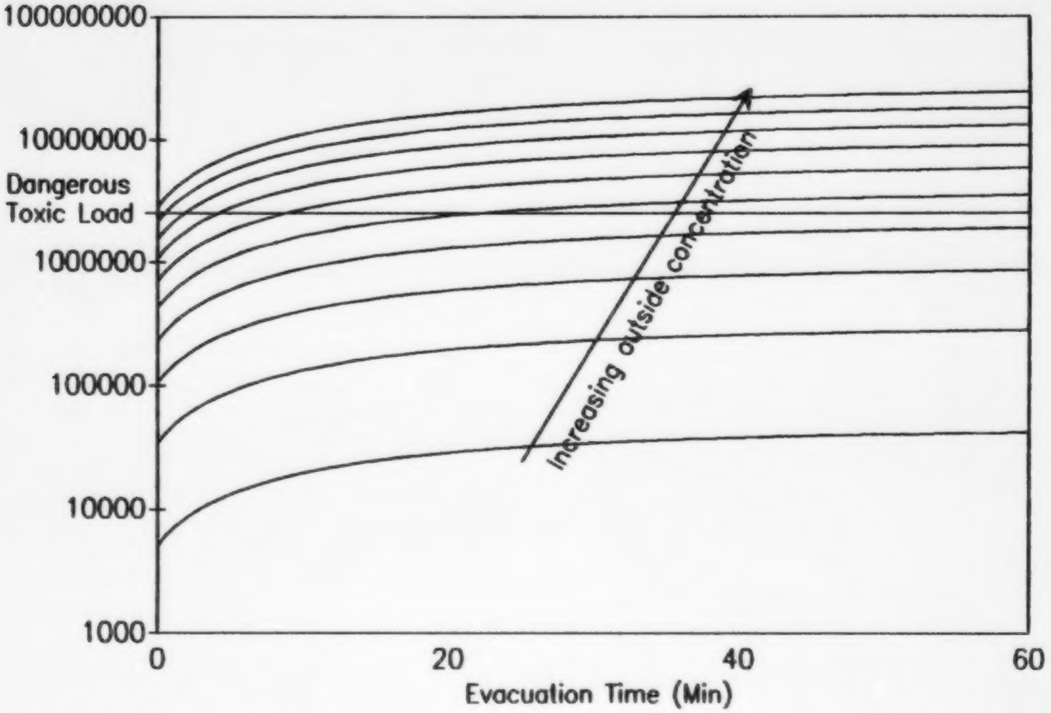

Figure 4, Indoor Toxic Loads Against Evacuation Time for a 10 min Release, Ventilation Rate=1ach. Effect of Outside Concentration

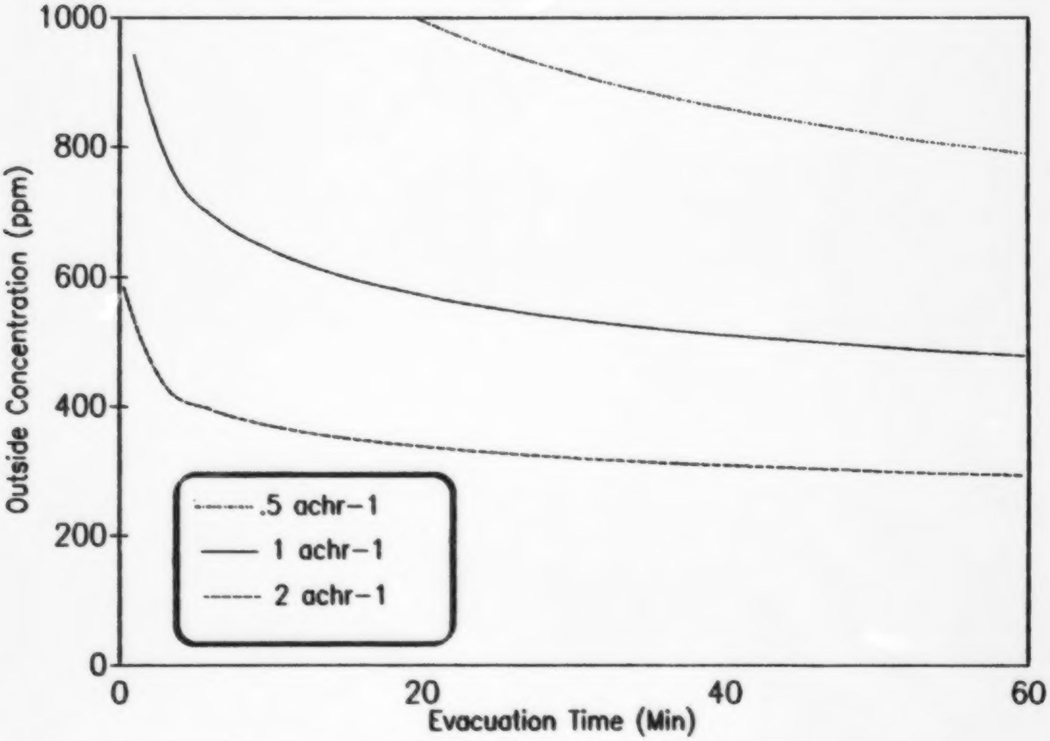

Figure 5, Given 10minute Release , Time Available For Evacuation for 3 Ventilation Rates

LE COMITÉ DE COORDINATION DES ACCIDENTS MAJEURS

Pierre Brien
Coordonnateur et secrétaire
du groupe de planification
fédérale et provinciale

Protection civile Canada

INTRODUCTION

Le comité de coordination des accidents industriels majeurs constitue une formule inédite de coordination et de concertation pour examiner les problematiques des substances dangereuses et développer des consensus sur les stratégies permettant de faire face et prévenir ou réduire le danger potentiel de ce risque technologique.

C'est comme pionnier contribuant et partenaire à ce système que je désire vous faire partager mon enthousiame à cet expérience mobilisatrice.

1. Origines du CCAIM

Le CCAIM est issu d'un groupe de travail qui a effectué la mise à jour du rapport sur l'après-Bhopal et a établi un ordre de priorité parmi les recommendations qui furent formulées. Il devenait évident pour nos représentants des ministères fédéraux (Protection civile Canada, Environnement Canada et Transports Canada), des gouvernements provinciaux (Alberta, Saskatchewan et Québec) et de l'association canadienne des producteurs chimiques d'élargir la base en un véritable comité canadien avec d'autres représentants du secteur privé des associations spécialisées, des municipalités, des universités et d'autres partenaires.
Un comité intérimaire de coordination fut constitué en vue de créer la nouvelle structure et de l'officialiser dans une assemblée de fondation.
La problématique des accidents industriels majeurs fut débattue de telle sorte que la légitimité de la démarche ne faisait plus de doute et les participants proposèrent un objectif, des buts et un programme de travail pour la première année. Un comité de coordination confia à des groupes de travail le soin d'approfondir certaines questions et de produire, selon les cas, des politiques, des instruments de travail, des guides ou, à tout le moins, des orientations.

Cette formule de participation a permis d'impliquer plusieurs partenaires dans les groupes de travail et de mettre à contribution le plus grand nombre possible de membres.

MIACC Objective	**Objectif du CCAIM**
"to provide for all interested parties a focus for actions and leadership to reduce major accidents involving dangerous substances in terms of number and severity as they impact on public safety, health and the environment, by improving prevention, preparedness and response programs".	"attirer l'attention des principaux conernés et susciter le leadership nécessaire aux programmes qui permettent de diminuer l'impact des accidents industriels majeurs causés par des substances dangereuses à l'égard de leur fréquences et gravité parce qu'ils ont un incidence sur la protection des citoyens, la santé publique et l'environnement en améliorant les programmes de préventions, l'état de préparation et les capacités d'intervention.
MIACC Goals	**Buts du CCAIM**
MIACC strives to:	Les effets du CCAIM convergent vers:
a) a significant reduction in the risk or probability of major accidents involving dangerous substances.	a) Une réduction voire atténuation significative du risque ou probabilité que des accidents industriels majeurs de substances dangereuses se produisent;
b) a significant improve-in the ability to respond effectively should such an accident occur, and	b) Une amélioration significative de la capacité d'intervention dans l'éventualité d'un accident, et,

c) regular measurable progress which is apparent, credible, and made known to the general public.	c) des progrès mesurables qui soient évidents, crédibles et connus du public canadien.
MIACC Terms of Reference	**Termes de référence du CCAIM**
The TORs adopted by the Steering Committee in January 1988 state that MIACC wilwl:	Les termes de références tels qu'ils furent adoptés en janvier 1988 permettent d'énoncer que le CCAIM:
1. Review activities, promote strategies and research, by actively seeking commitment from all participants and by monitoring progress towards the achievement of the objective.	1. Examine de façon continue les activités, fasse la promotion des stratégie arrêtées et de la recherche, en suscitant l'engagement de tous les collaborateurs et en catalysant toutes les énergies à l'atteinte de l'objectif.
2. Have a coordinating role amongst interested groups.	2. Exerce un rôle de coordination parmi les groupes interessés à la démarche.
3. Provide a forum for information exchange on programs and activities related to major accidents through newsletters and other communications.	3. Procure un forum rendant possible l'échange d'information sur les programmes et activités rattachés aux accidents industriels majeurs par des bulletins d'information et autres moyens de communications.
4. Establish and maintain and inventory of existing and planned activities related to achieving the objective.	4. Établit et maintient un inventaire sur les activités en cours et celles planifiées en relation avec l'objectif.

2. Les Réalisations du CCAIM

Le CCAIM a déjà à son actif deux réunions annuelles.

En l'an 1 (1988) du CCAIM, la présidence était assumée rotativement par trois fonctionnaires fédéraux du niveau de directeurs généraux (Protection civile Canada, Transports Canada et Environnement Canada). Le secrétariat qui était formé de fonctionnaires de ces trois ministères a assuré la continuité et le suivi des travaux entre les réunions du comité de coordination et a préparé les réunions annuelles. Il a vu de plus à diffuser un bulletin de nouvelles.

En 1989, une mutation s'est produite avec la présidence qui est exercée par M. Jean Bélanger, président de l'Association canadienne des producteurs chimiques.

Les principales réalisations et activités passent par l'implication des organismes participants dans leurs sphères respectives d'activités et par les groupes de travail qui ont été constitués. Certaines initiatives sont dignes de mention pour une assemblée telle que la vôtre:

- Un rapport sur les méthodes d'analyse et d'évaluation des risques a été déposé et permet d'entrevoir des définitions de base sur les plus importants concepts et de mieux connaître les caractéristiques et l'étendue des méthodes d'analyse.

- Un guide de Protection civile Canada à l'intention des municipalités sur l'état des préparation est axée et la planification de divers types d'urgence dont ceux concernant les matières dangereuses selon une approche multirisques. Il y a lieu d'indiquer que la préparation des plans d'urgence et des mesures d'intervention relève de la compétence des municipalités qui peuvent bénéficier des conseils et de l'assistance des organismes provinciaux de protection civile.

- Le systèmes actuels d'information sur les matières dangereuses (les rapports d'accidents de Transports Canada et les cas de déversements du système national d'analyse des tendances d'urgence d'Environnement Canada) sont d'avantage compatibles et s'alignent sur la complémentarité de nouvelles bases de données.

- Une étude de besoins auprès des grandes entreprises et des petites et moyennes entreprises par l'Association canadienne des producteurs chimiques et l'Association des manufacturiers canadiens favorise la consolidation et l'amélioration des plans chez ceux qui en ont, incite les autres à se doter d'un plan et dans l'application du programme CAER favorise l'intégration de ces plans avec ceux de la municipalité. L'échange d'information et la transparence entre ces deux ordres d'intervention sont des conditions de coopération que le CCAIM promouvoit. Un guide à l'intention des industries a été préparé à cette intention.

- Des plans de communications sont coordonnées et adaptés à divers groupes cible et selon les mandats confiés par le CCAIM.

- La préparation de documents sur des thèmes rattachés à la prévention des accidents industriels majeurs aide à la promotion des mesures préventives.

Ce système que représente le CCAIM a été jusqu'à présent un catalyseur et un mécanisme de promotion et de coordination auprès des organisations, des ordres de gouvernments et entreprises qui ont la compétence et l'autorité de prendre les décisions nécessaires pour faire diminuer la fréquence et minimiser l'impact des accidents industriels majeurs visant des substances dangereuses.

3. Perspectives d'avenir

Les stratégies retenues par le CCAIM pour s'assurer de la poursuite des actions déjà entreprises se veulent mobilisatrices et dynamiques.

Ainsi, dans le cadre d'une participation équilibrée de tous les partenaires du CCAIM, tous sont appelés à apporter des contributions concrètes au sein du comité de coordination, dans les groupes de travail ou de toute autre façon jugée pertinente et utile. Afin d'inciter à la participation, il a été jugé primordial de diffuser une information pertinente sur les programmes et activités du CCAIM.

La préparation et la promotion de guides, de documents d'orientation et de codes de pratiques demeure une priorité et l'accent est mis sur leur acceptation volontaire.

Une meilleure communication et la coordination doivent s'appuyer sur une secrétariat permanent efficace et la régionalisation du CCAIM.

Le CCAIM est certes actif au niveau national par les activités assumées par son secrétariat et celles générées par son comité de direction auprès des groupes de travail. Cette structure multi-latérale doit reposer sur la participation de ses membres. Il faut rejoindre les membres dans leur province, leur région, leur municipalité. Ce décloisement nécessite une implication des provinces à mettre sur pied une structure ouverte au partenariat et garante d'actions concrètes par les divers ordres du gouvernement et le secteur privé. Dans cette décentralisation, il ne faut pas perdre de vue les objectifs globaux et les priorités du CCAIM, tout en laissant place à des adaptations et des objectifs spécifiques et répondant aux besoins particuliers des provinces. Il est possible que ce processus de décentralisation se poursuive jusqu'au niveau régional (municipalités régionales de comtés, communautés urbaines ou régionales, districts, zones et autres formes de regroupement municipal) et mobilise des ressources directement concernées et dont les activités ont des impacts presqu'immédiat et se situent dans un contexte d'entraide mutuelle.

L'Alberta s'est déjà dotée d'un CCAIM provincial, un peu à l'instar du CCAIM national, en convoquant une conférence de fondation sur la base d'objectifs concordants et avec la mise sur pied d'un comité de direction. Les partenaires proviennent également des trois ordres de gouvernment, du secteur privé, de diverses associations ou organismes non gouvernementaux et des universités. Le comité provincial de protection civile du Québec dans son rôle de coordination a constitué des groupes de travail dont l'un est en définitive un comité interministériel sur le matières dangereuses et entrevoit de se donner un groupe de travail avec le secteur privé pour mieux planifier et coordonner les actions prises en ce domaine.

Certaines provinces ont un comité interministériel sur le transport des marchandises dangereuses et d'autres ont des comités ad hoc composés de représentants du fédéral et du provincial qui sont convoqués au besoin et lorsque des interventions concertées s'imposent.

Des régions comme celle de Sarnia, en Ontario, et Shawinigan-Grand-Mère, en Haute-Mauricie, ont des programmes d'entraide industrielle-municipale qui datent de près de 30 ans. Ce ne sont là que des points de repère puisque depuis on peut citer plusieurs endroits dont Vancouver, Edmonton, Windsor, Amherstburg, Hamilton et Toronto, l'Est de Montréal au sein de la communauté urbaine de Montréal, Bécancour, Trois-Rivières, Cap-de-la-Madeleine, Varennes, Halifax-Dartmouth... Les programmes de coopération se retrouvent par conséquent dans des municipalités régionales, des zones, districts ou autres formes de regroupement inter-municipal. Une délimitation des fonctions exercées au niveau national et provincial dans le processus de régionalisation est à se produire de sorte que le système voit le forum national s'extensionner régionalementalement en province et au niveau local.

CONCLUSION

L'expérience canadienne du CCAIM a été l'objet de présentations lors de forums internationaux ou de réunions d'organismes multilatéraux tels les Nation-Unies (programme des Nation-Unies pour l'environnement) et l'organisation de coopération et de développement économique (groupe ad hoc d'experts sur les accidents liés aux substances dangereuses). Fort de ce vécu, nous pouvons maintenant témoigner d'un système qui pourrait convenir à des pays y voyant une formule transférable.

MARINE POLLUTION RESPONSE ORGANIZATION IN THE UNITED STATES

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ABSTRACT

Oil and hazardous substances spill response in the United States is governed by the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). The NCP provides the framework about which the Federal response organization operates, both in contingency planning for spill response and for response operations. Federal spill response at the local level is directed by the pre-designated Federal On-Scene Coordinator (FOSC). The purpose of this paper is to outline the Federal response organization under the NCP and the local response organization of the Federal On-Scene Coordinator developed to carry out response activities. It will also describe a new system under development by the U.S. Coast Guard to provide computerized information to on-scene response personnel.

INTRODUCTION

In the United States, all marine pollution response activities carried out by the Federal government are guided by the requirements contained in the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). The NCP was originally developed to implement oil spill cleanup responsibilities for spills into navigable waterways covered by Section 311 of the Federal Water Pollution Control Act, as amended (FWPCA). It was expanded considerably in 1982 to implement the responsibilities for response to hazardous substances releases into navigable waters, groundwater, on land, and into the air covered by the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA). These are the two major statutes that affect spill response in the United States.

The NCP, first developed in the late 1960's and updated numerous times since then, provides the framework about which the various Federal agencies operate when a spill occurs. It identifies responsibilities of Federal, state, and local governments and private entities for spill response, establishes the national response organization that may be brought to bear during a response action, specifies regional and local contingency planning requirements, and provides for specific procedures for use of dispersants or

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The views in this paper reflect those of the authors and may not necessarily reflect the views of the U.S. Coast Guard or the United States government.

other chemical agents to mitigate the effects of a spill. The first part of this paper focuses on the national response organization outlined in the NCP and the functions of each level in the organization. Figure 1 provides an outline of this organizational structure. The second part of this paper will focus on the U.S. Coast Guard's proposed Spill Response Information System (SRIS) utilizing the National Oceanic and Atmospheric Administration (NOAA) Computer-Aided Management of Emergency Operations (CAMEO) System, a project to assist operations personnel in dealing with chemical emergencies.

NATIONAL ORGANIZATION

At the national level, planning and response activities are coordinated through the National Response Team (NRT). The NRT is made up of national representatives from fourteen different Federal agencies within the U.S. government with environmental, health, or transportation-related responsibilities. The U.S. Environmental Protection Agency representative acts as the Chairman of the NRT and the U.S. Coast Guard representative acts as the Vice-Chairman. Figure 1 identifies those agencies that make up the NRT.

The primary function of the NRT is to act as a standing committee to evaluate methods for responding to oil or hazardous substance spills, to recommend needed changes in response organization, and to recommend revisions to the NCP based on spill response experiences, changes in statutory authority, etc.

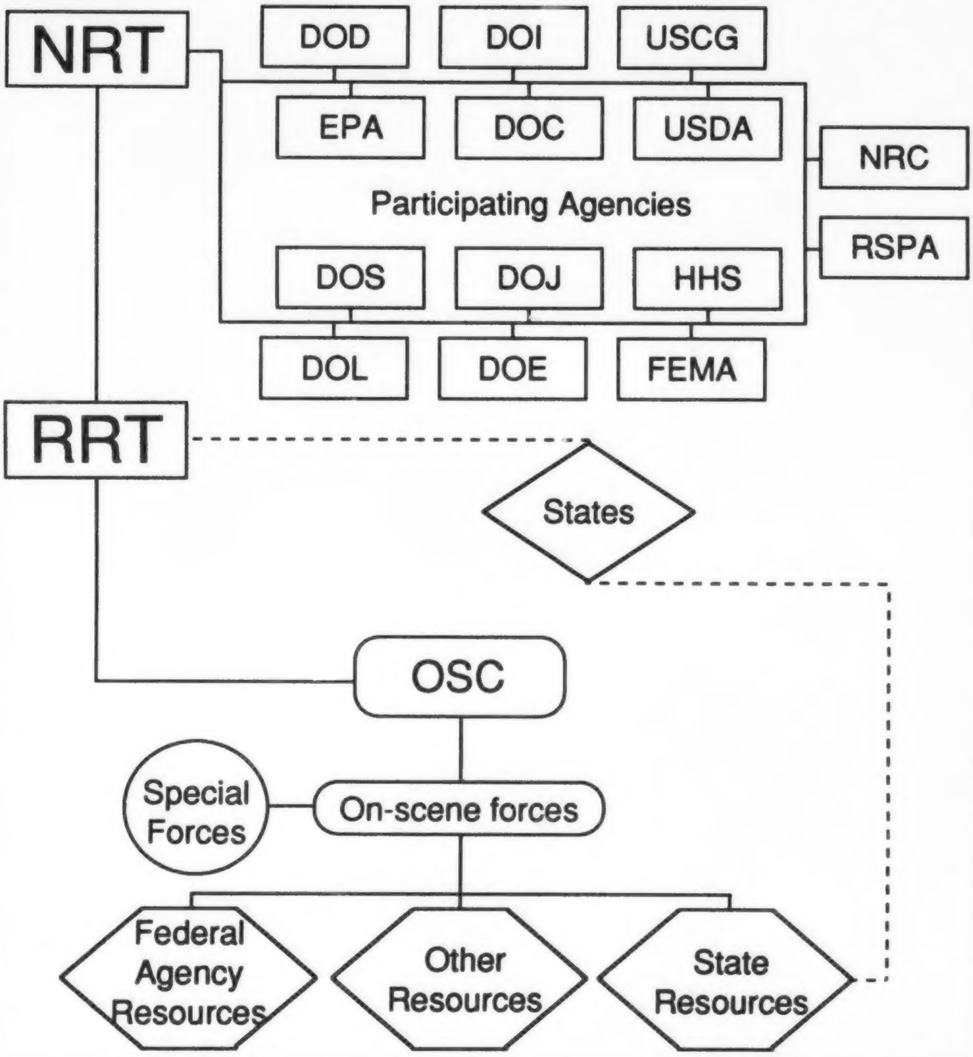
In addition to it's primary planning responsibilities, the NRT serves as an emergency response team to provide, through the Regional Response Team, advice, recommendations, or assistance to the Federal On-Scene Coordinator. It also coordinates requests for resources that are not available or accessible at the local or regional level and the supplying of these resources to the affected region. The NRT becomes involved in a spill response on those infrequent occasions where the incident exceeds the regional response capability, affects more than one region, or involves significant national policy issues. When activated for a response, the Team is chaired by the agency that has been pre-designated to act as Federal On-Scene Coordinator for the incident.

REGIONAL ORGANIZATION

At the regional level, planning and response activities are coordinated through the Regional Response Team (RRT). The RRT is made up of regional representatives of the NRT member agencies, plus representatives of each state located within the region. Representatives of industry and cleanup cooperatives also participate as associate members. Thirteen RRTs have been established in the United States; one for each of the ten standard Federal regions and one in Alaska, Oceania (covering Hawaii, Guam, American Samoa, the Commonwealth of the Northern Mariana Islands, and the other U.S. Territories in the Pacific), and the Caribbean (covering Puerto Rico and the U.S. Virgin Islands). Figure 2 shows the areas covered by each RRT.

Figure 1

National Contingency Plan Concepts


NRT
DOD
DOI
USCG
EPA
DOC
USDA
NRC
Participating Agencies
RSPA
DOS
DOJ
HHS
DOL
DOE
FEMA
RRT
States
OSC
Special Forces
On-scene forces
Federal Agency Resources
Other Resources
State Resources

NRT Member Agencies

DOD - Department of Defense
DOI - Department of the Interior
USCG - U.S. Coast Guard
EPA - Environmental Protection Agency
DOC - Department of Commerce
USDA - U.S. Department of Agriculture
NRC - Nuclear Regulatory Commission
RSPA - Department of Transportation Research and Special Programs Administration

DOS - Department of State
DOJ - Department of Justice
DOL - Department of Labor
DOE - Department of Energy
FEMA - Federal Emergency Management Agency
HHS - Department of Health and Human Services

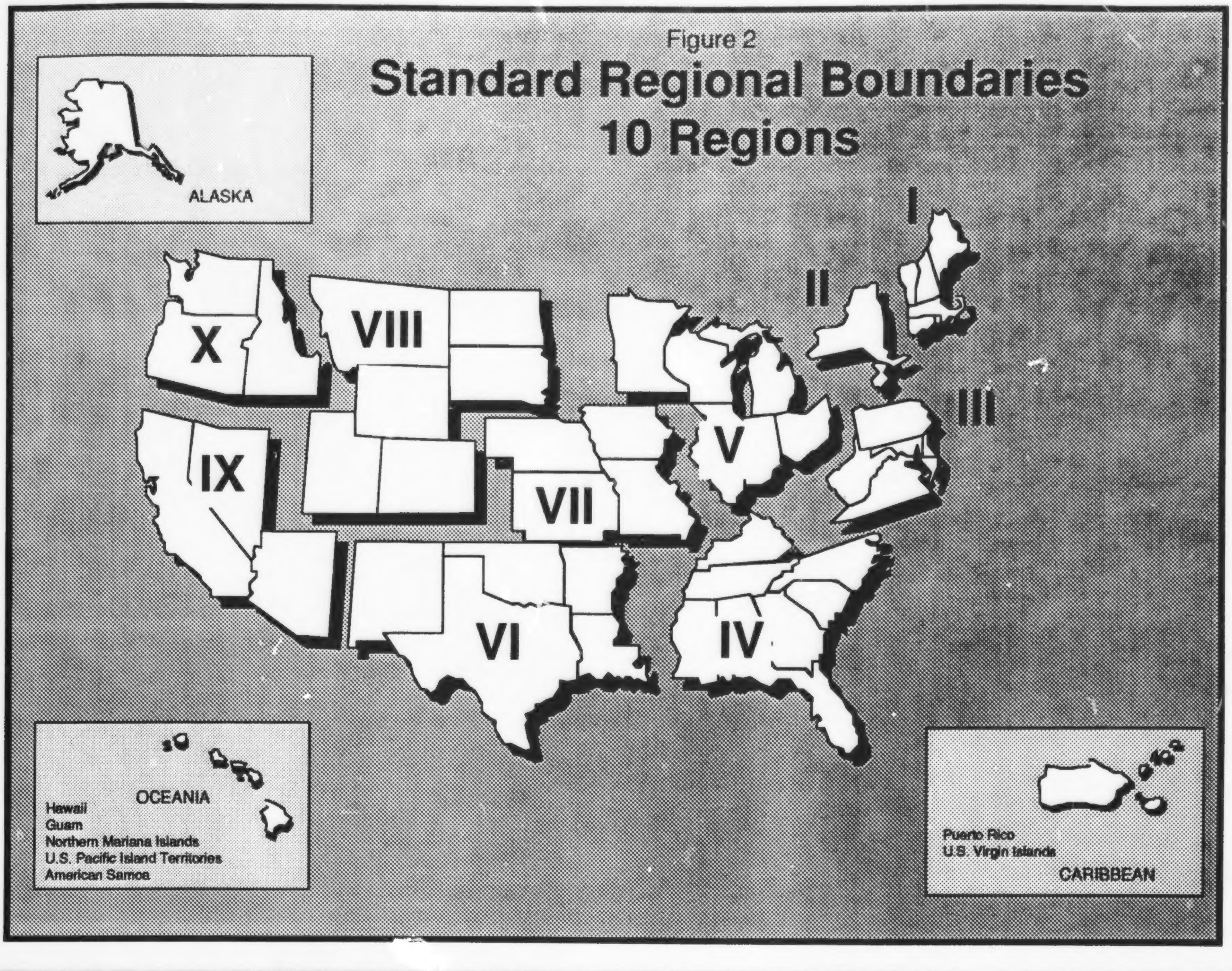


Figure 2

Standard Regional Boundaries
10 Regions

ALASKA
I
II
III
IV
V
VI
VII
VIII
IX
X
OCEANIA
Hawaii
Guam
Northern Mariana Islands
U.S. Pacific Island Territories
American Samoa
Puerto Rico
U.S. Virgin Islands
CARIBBEAN

The RRT serves as the regional counterpart to the NRT, providing the mechanism at the regional level for planning and preparedness activities before a spill occurs, and for coordinating regional support and advice to the Federal On-Scene Coordinator during a spill. Since the inception of the Federal response organization under the NCP, this part of the organization has undergone the most changes. Originally, states were invited to participate in RRT activities, but were not direct RRT members. In 1982, the NCP was revised to make states full members of the RRT. The most recent revision, which occurred in 1986, divided the RRT into two functional groups: a Standing RRT and an Incident-Specific RRT. Prior to 1986, these functions were performed by the same group of representatives, resulting in a perception by some of a lack of focus on the RRTs important planning responsibilities. Recognizing this, the NRT recommended revisions to the NCP, which became effective in February 1986, that separated the planning and response activities of the RRT.

The Standing RRT, made up of all RRT members, serves to provide recommendations on revisions to the regional response organization, to develop and maintain an up-to-date regional contingency plan, and to evaluate the preparedness of agencies for a Federal response within the region. Specific responsibilities of the Standing RRT include maintaining one regional contingency plan that provides for a coordinated, timely, and effective response to an oil or hazardous substance spill within the region that exceeds the local response capability. Prior to 1984, there were separate contingency plans covering the inland and coastal areas of a region. These were consolidated into one plan covering the entire region. This change was necessary because of expanded Federal jurisdiction for hazardous substance spills resulting from the passage of CERCLA in 1980. This single plan is coordinated with the contingency plans of the states and any Federal local contingency plans. Another major RRT responsibility is the review of response actions that are carried out within the region to identify deficiencies in response coordination, equipment readiness, or contingency plans, and to make recommendations to correct those deficiencies. Three new responsibilities added with the restructuring in 1986 include considering pre-planning for, and if appropriate, the pre-approval of the use of dispersants and other chemical agents to mitigate the effects of an oil spill; conducting training exercises as necessary to encourage preparedness activities within the region; and taking a more active role with the state and local response community to improve their response preparedness. The regional representatives of the U.S. Environmental Protection Agency and the U.S. Coast Guard act as co-chairmen of this standing body.

The Incident-Specific RRT is activated when an oil or hazardous substance spill occurs that exceeds the response capabilities of the Federal On-Scene Coordinator, crosses pre-designated Federal On-Scene Coordinator zones or regional boundaries, or involves regional issues. The make-up of the team will depend on the specific incident. It usually involves those members of the Standing RRT with specific technical expertise or geographic jurisdiction over an incident. Thus, it could involve only a small number of representatives or the entire standing Team. Specific responsibilities of the Incident-Specific RRT include providing advice and recommendations to the Federal On-Scene Coordinator on specific actions to respond to an incident, monitoring response operations, coordinating requests for resources that are not available at the local level, and ensuring that these resources are made available. The Incident-Specific RRT is chaired by either the EPA or Coast Guard representative to the RRT, depending on the location of the incident. It is important to stress that the RRT does not direct any response activity. It serves only to monitor the response and advise and assist as requested by the Federal On-Scene Coordinator.

LOCAL ORGANIZATION

At the local level, Federal planning and response activities are carried out by the pre-designated Federal On-Scene Coordinator (FOSC). The U.S. Coast Guard acts as FOSC for the coastal areas of the U.S., the Great Lakes, and certain inland rivers, and the U.S. Environmental Protection Agency acts as FOSC for all other inland areas of the U.S. In addition, certain Federal agencies, such as the Department of Defense and Department of Energy, have been designated to act as FOSC for certain incidents involving their vessels and facilities. A FOSC has been pre-designated for all areas within the U.S.; actual boundaries between FOSCs are negotiated at the local level to account for geographic and demographic features, transportation patterns, etc. The Coast Guard has 48 pre-designated FOSCs throughout the country, each with jurisdiction over a specific coastal area, and EPA has a number of OSCs in each of their 10 Regional offices to cover the inland areas of the country.

While the primary role of the FOSC is to coordinate Federal spill response activities at the local level, they do have certain planning and preparedness responsibilities. Each Coast Guard FOSC has developed and maintains a Federal Local Contingency Plan that identifies probable spill sources, local resource availability, and establishes a local organization for responding to an oil or hazardous substance spill. An important aspect of this contingency planning effort is the involvement of local representatives from all appropriate agencies and organizations, Federal, state, local, or private, in the planning process. The Federal Local Plan is developed to be compatible with the pollution, emergency, or disaster plans of other state or local entities, public and private. Recent amendments to CERCLA have resulted in the development of contingency plans specifically to address hazardous substances response at the local government level. FOSCs take an active part in the development of these local plans and sponsor training programs and spill exercises at the local level aimed at improving the response capabilities of the state and local government agencies.

As noted above, the primary role of the FOSC is to coordinate Federal response activities at the scene of an oil or hazardous substance spill. Specific responsibilities of the FOSC include investigating the circumstance of a spill; identifying potentially responsible parties and notifying them of their cleanup responsibilities under various Federal laws; evaluating the nature, amount, and location of a spill; assessing the potential impact of a spill on public health and safety, property, the environment, and any natural resources; establishing priorities for protecting public health, safety, and the environment; monitoring responsible party cleanup actions; ensuring that response actions are carried out safely; and, if necessary, conducting a Federally-funded spill cleanup. The FOSC is not involved in every spill that occurs in the U.S., however, the FOSC is notified of all spills reported to the Federal government that occur within his/her area of responsibility. The FOSC evaluates each reported spill and makes a determination on the need for Federal involvement. In most instances, the response can be handled by the local or state government and requires no Federal action. However, the FOSC will become involved if the spill is beyond the capability of the local or state government, or Federal funds are required to conduct the cleanup. In such cases, the FOSC's role may range from advising and monitoring the actions of a local government or responsible party to hiring a commercial contractor to conduct the cleanup.

While not part of the local organization on a regular basis, the Federal response organization includes certain other resources, identified as Special Forces in the NCP, to provide specialized local assistance to the FOSC. These include the National Strike Force, the Environmental Response Team, the Scientific Support Coordinator, and the Public Information Assist Team. The actual role of these resources in a response will depend on the specifics of the incident.

The National Strike Force (NSF), staffed by the U.S. Coast Guard, is made up of two Strike Teams. The Pacific Area Strike Team is located near San Francisco, California and covers the Western U.S. and the Pacific area. The Atlantic Area Strike Team is located in Mobile, Alabama and covers the Eastern and Southern U.S. and the Atlantic and Gulf coastal area. The NSF provides specialized equipment, technical assistance, and advice to both Coast Guard and EPA FOSCs when requested. They maintain an extensive inventory of oil spill containment and pumping equipment and hazardous substance spill response equipment that is used to supplement the equipment available from commercial cleanup contractors or private industry. In addition, they provide cost documentation, cleanup supervision, and safety monitoring to supplement the personnel resources available to the FOSC.

The Environmental Response Team (ERT), staffed by the U.S. Environmental Protection Agency, is made up of persons with expertise in biology, chemistry, hydrology, geology, and engineering. The ERT is available to assist FOSCs in hazard evaluation, sampling and analyses, environmental assessment, identification of cleanup methods, how clean-is-clean determinations, and waste disposal.

The Scientific Support Coordinator (SSC), provided by the National Oceanic and Atmospheric Administration (NOAA) in the coastal areas of the U.S., is available at the request of the FOSC to provide scientific support for operational decisions made by the FOSC. The SSC generally serves as the principal liaison with the local scientific community to collect and analyze scientific information that would assist the FOSC carry out his/her responsibilities.

The Public Information Assist Team (PIAT), staffed by the U.S. Coast Guard, is available to assist the FOSC meet the demands for public information and community relations during a spill response.

LOCAL RESPONSE ORGANIZATION

As noted in the previous section, each Federal Local Contingency Plan includes the outline of a local response organization for responding to oil or hazardous substance spills within the FOSC's zone. No two OSC zones are exactly alike, thus the make-up of the local response organization (sometimes referred to as the Local Response Team) varies from zone to zone. Each organization, however, is based on the same concepts. These concepts include a command structure and direct support staff addressing safety, public information, planning, and liaison, and organizational elements that address operations, finance, and logistics. An example of a typical FOSC response organization is shown in Figure 3.

At the head of the organization is the FOSC. He/she is the individual responsible for coordinating and/or directing the Federal response activities resulting from a spill. As such, the FOSC is involved in all aspects of the response, making decisions based on staff input that will guide the direction of activities for containment, removal, and disposal of the spilled material and the taking of other actions necessary to protect public health, property, or the environment from damages resulting from the spill. The FOSC is "in-charge" of the Federal forces brought to bear to address a particular incident, and acts as the principal liaison with the responsible parties, other government agencies, and the public for actions related to the response.

The FOSC has a number of staff to assist him/her in carrying out specific responsibilities. The number of persons carrying out these responsibilities will depend on the size or complexity of the incident, however, each responsibility is important and is generally performed for all incidents. The FOSC's immediate staff includes an assistant FOSC, a Public Affairs Officer, a Planning/Liaison Officer, a Safety Officer, a Legal Officer, and a Documentation Officer or Historian. These are in addition to the support provided to the FOSC through the NRT, RRT, NSF, ERT, and SSC as discussed above. Each role has specific responsibilities assigned. The following summarizes the major responsibilities of each:

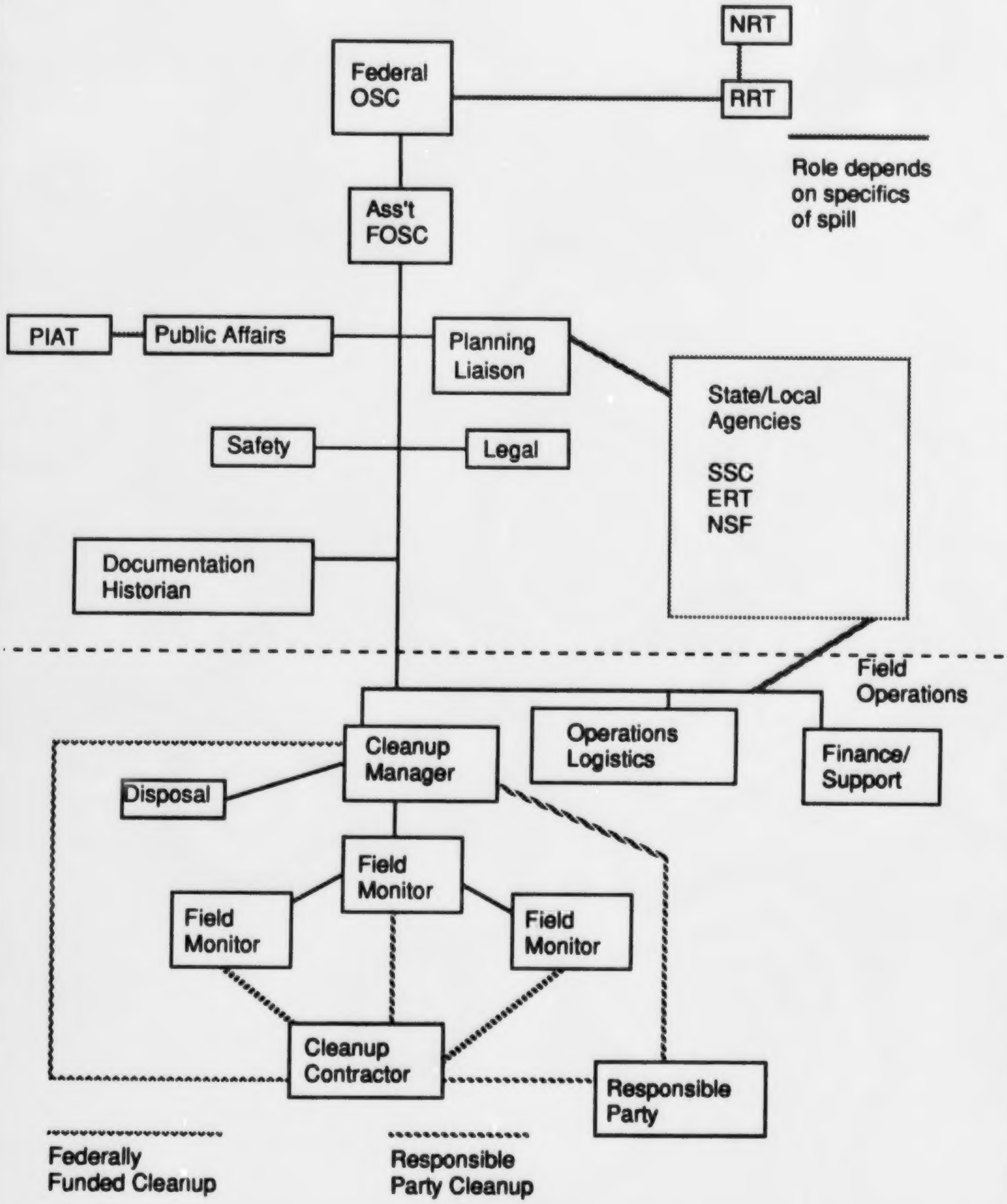
Assistant FOSC - Assists the FOSC through direct supervision of the FOSC's staff; ensures the flow of information between the FOSC and the various supporting elements; organizes daily FOSC staff meetings to discuss progress and strategies for cleanup operations.

Planning/Liaison Officer - Develops plans and strategies for cleanup activities; identifies resources required to carry out cleanup strategy; acts as liaison with Special Forces and other outside response groups.

Public Affairs Officer - Provides public information/community relations support for the FOSC; drafts press releases for release by the FOSC; schedules press briefings; coordinates public information activities of the various involved agencies; establishes and manages the on-scene news office and day-to-day liaison with news media and the public.

Figure 3

Local Response Organization



NRT

Federal OSC

RRT

Role depends on specifics of spill

Ass't FOSC

PIAT

Public Affairs

Planning Liaison

State/Local Agencies

SSC
ERT
NSF

Safety

Legal

Documentation Historian

Field Operations

Cleanup Manager

Operations Logistics

Finance/ Support

Disposal

Field Monitor

Field Monitor

Field Monitor

Cleanup Contractor

Responsible Party

Federally Funded Cleanup

Responsible Party Cleanup

Safety Officer - Oversees safety-related issues of the response; ensures appropriate safety measures are taken to protect the response workers and the public; makes recommendations on appropriate levels of personal protective equipment to be used during the response; ensures compliance with all applicable safety regulations and procedures.

Legal Officer - Provides recommendations to the FOSC on legal issues that arise during a response; acts as liaison with the responsible party's legal representatives.

Documentation Officer/Historian - Maintains all FOSC records related to the spill; maintains chronological logs of cleanup activities, status boards, and other information that documents the response; collects photographs, charts, and other information to fully document response activities.

Under the FOSC's immediate staff are the organizational elements that oversee the day-to-day field activities. These include the Cleanup Manager, Operations and Logistics Officer, Finance and Support Officer, Disposal Officer, and Field Monitors. As with the FOSC's immediate staff, each role has specific responsibilities. The following summarizes the responsibilities of each:

Cleanup Manager - Manages day-to-day cleanup activities; carries out cleanup strategies based on policy and direction by the FOSC; mobilizes cleanup resources as required and maintains direct liaison with responsible parties or commercial contractors; supervises Field Monitors and Disposal Officer; ensures appropriate cost documentation is collected, and reviews contractor's daily invoices.

Operations/Logistics Officer - Maintains communications network for response activities; arranges for boats, vehicles, and aircraft as necessary to support field activities; assists in locating resources required to conduct a cleanup; monitors and/or controls marine traffic near the cleanup.

Finance/Support Officer - Oversees management of personnel assigned to cleanup activities; administers contracts for required cleanup contractors, equipment, and supplies necessary for cleanup; compiles cost documentation and keeps up-to-date records on costs incurred; reviews all invoices and forwards for payment as appropriate; administers and manages staging area for equipment and supplies used for the cleanup.

Disposal Officer - Oversees disposal of wastes generated during the cleanup; ensures compliance with applicable Federal, state, or local requirements for disposal; maintains documentation required to support cost recovery and to show compliance with required regulations.

Field Monitor(s) - Oversees cleanup activities in assigned area as directed by Cleanup Manager; makes recommendations on personnel, equipment, and supplies necessary to conduct cleanup in assigned area; monitors and documents cleanup activities carried out in assigned area; acts as a field safety observer to ensure compliance with safety requirements.

As is shown in Figure 3, the interface between the FOSC's local organization and the cleanup contractor will depend on whether the cleanup is being conducted by the responsible party or being financed by the Federal government. In a responsible party cleanup, the FOSC's Field Monitors will monitor the actions being taken by the responsible party and report back through the chain-of-command. If changes are necessary, the FOSC or Cleanup Manager will work through the responsible party's on scene representative to recommend changes in response strategy, additional equipment requirements, etc. In a Federally-funded cleanup, the commercial contractor will receive direction from the Cleanup Manager, and the Field Monitors will ensure that the daily work is completed safely and effectively, making minor modifications to the work as conditions change throughout the day.

Another aspect of the local response organization is the interface between the FOSC and the local government agencies. Here again there are differences in how the local response organization operates. In some areas, the FOSC's internal organization is established separately, with the FOSC and his/her immediate staff acting as liaisons as necessary to ensure a coordinated response effort. In other areas, the local agencies are fully integrated into the FOSC's organization, performing many of the tasks described above. How a specific FOSC organizes is dependent on the particular response situation, the availability and capabilities of the local organizations, etc. The primary goal of any organization established is to ensure a safe, effective, and coordinated effort to address the issues and problems posed by the particular incident.

It is important to note that the primary role of the FOSC in this local organization is to coordinate Federal spill response activities and to assist local response organizations as necessary. The FOSC is not necessarily "in charge" of response activities being carried out. Responsibility for directing or being "in charge" of a response remains at the most local level of the organization capable of handling the responsibilities, be it the municipal, county, or state government. More importantly, the FOSC's role is to coordinate the activities of these various agencies and organizations with expertise in specific areas to ensure that a spill is cleaned up safely, efficiently, and effectively.

U.S. COAST GUARD PROPOSED SPILL RESPONSE INFORMATION SYSTEM

In an effort to improve personnel response to oil and hazardous substances pollution incidents, the Coast Guard conducted a pilot project from October 1987 - October 1988 to develop and evaluate a locally-maintained response information system. This system is based largely on the National Oceanic and Atmospheric Administration's (NOAA) program for emergency response management called CAMEO (Computer-Aided Management of Emergency Operations). CAMEO operates on the Macintosh Computer using Apple Computer's HyperCard 1.1 and other drawing and communications software. The program is designed for emergency planners and first responders so that they can better manage a potential or actual hazardous material incident.

CAMEO Features: CAMEO is capable of performing the following functions:

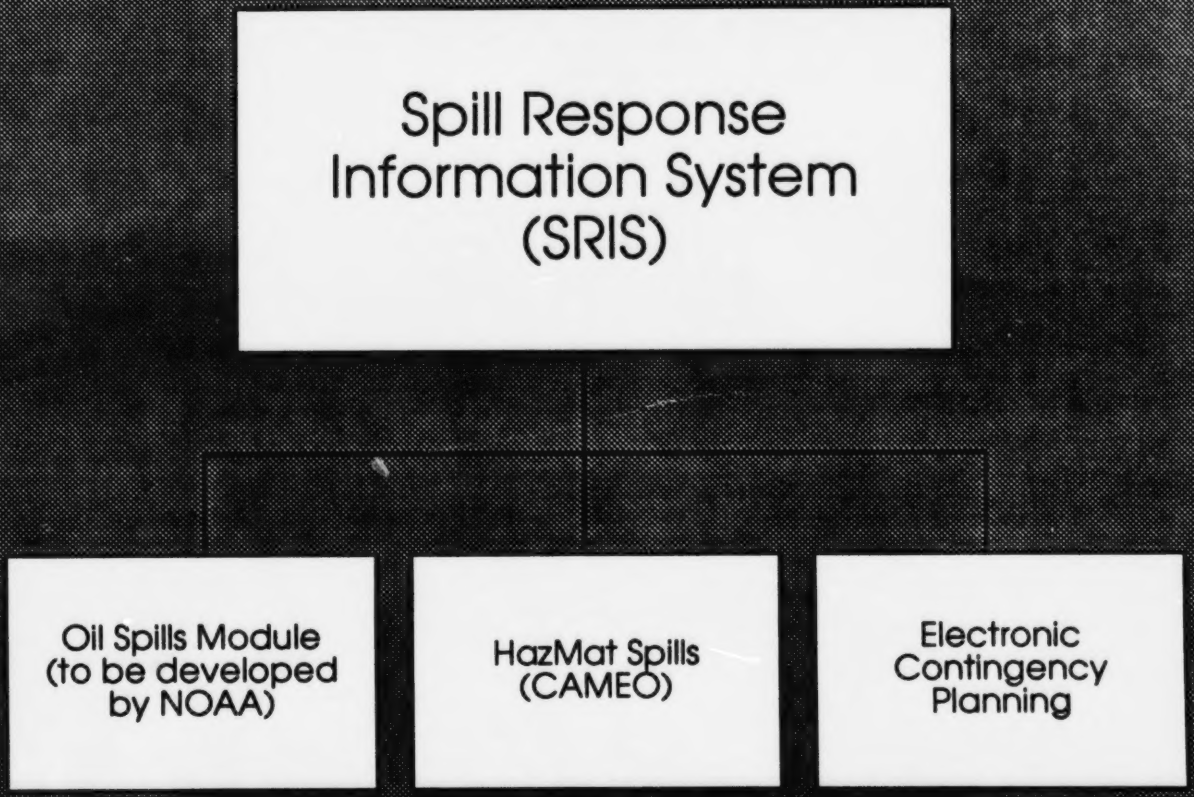
- Electronic mapping of transportation routes and places of interest such as ports, harbors, streets, factories, warehouses, schools, hospitals, parks and other landmarks;
- Graphical depiction of chemical facilities including interior floor plans, tank and storage locations, building orientation, and street access;
- Identification of 2,629 chemicals including their various identification numbers, labeling requirements, and most commonly used synonyms;
- Providing response recommendations and chemical information on each chemical included in the database covering physical/chemical properties, fire and explosion hazards, health hazards, firefighting techniques, protective clothing recommendations, spill cleanup procedures, and first aid procedures;
- Modeling of air dispersion of a released chemical and predicting downwind chemical concentrations from a spill;
- Performing vulnerability/risk scenarios with an ability to vary environmental conditions such as air speed, chemical concentration, release time, etc., and graphically displaying the results;
- Maintaining a database on population centers of interest (i.e., schools, hospitals, shopping centers, etc.) including information on hours of operation, average number of people, and appropriate points of contact.

Results from the pilot project indicate that the CAMEO system has a number of advantages over present Coast Guard response methods. For example, the Coast Guard's Hazard Assessment Computer System (HACS) can provide chemical characteristics, toxicity informations, and spill trajectory models in about two to three hours, depending on the complexity of the case. CAMEO can provide similar, although not as accurate, information in five to fifteen minutes. In addition, CAMEO's ability to overlay predicted plume concentrations over a map of an area is easier to rapidly interpret than the numerical printouts provided by HACS. The end result is a more area-specific model of a spill's predicted dispersion, making hazard analysis more meaningful. Additionally, CAMEO can provide information on protective clothing recommendations; HACS does not have similar capability. Furthermore, HACS contains information on only 900 chemicals. Another Coast Guard system known as the Chemical Hazards Response Information System (CHRIS) contains information on 1,016 chemicals. CAMEO encompasses both of these systems and includes information on a total of 2,629 chemicals,including 50,000 of their most commonly used synonyms and tradenames. This large database enables CAMEO to speed the identification of an unknown chemical and eliminates the need for a large, awkward, and often time consuming on-scene reference library.

CAMEO's technology will improve two areas in the Coast Guard's environmental response program: electronic contingency planning (i.e., graphic illustration of port maps/charts and response/notification databases with an ability to tie into the NRT/RRT/FOSC electronic mail network) and oil spill trajectory modeling. NOAA is currently developing an oil spill module that includes a tide/tidal current database and operates in a manner similar to CAMEO's air plume model. The components of the Coast Guard's new Spill

Response Information System (SRIS) system, mentioned at the beginning of this paper, are depicted in Figure 4.

The implementation of CAMEO throughout the Coast Guard and the further development of SRIS will enable the Coast Guard to better fulfill its responsibilities under the Clean Water Act and CERCLA. Coast Guard response teams will be able to more rapidly assess the potential hazards and impact of a hazardous material incident with less risk to themselves, the general public, and the environment.



Spill Response Information System (SRIS)

Oil Spills Module (to be developed by NOAA)

HazMat Spills (CAMEO)

Electronic Contingency Planning

Figure 4

TRAINING IN MARINE EMERGENCY PROCEDURES FOR INCIDENTS INVOLVING DANGEROUS GOODS

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INTRODUCTION

Accidents can occur in any industry in spite of the most vigorous efforts to prevent them. In many parts of the shipping industry, and in particular where the transportation of potentially hazardous goods such as bulk chemicals or liquefied gases or containerised or packaged dangerous goods are concerned, there have been cases where loss, measured in both human and monetary terms, has been severe. It is equally true to say that there have been other cases where, because of effective action taken in time, the full potential loss has been largely avoided. Effective action, in these cases, has been possible due to the existance of pre-planned and practical procedures for handling emergencies and because personnel have been effectively trained in the implementation of these procedures.

The existence of practical emergency procedures and well trained personnel are however often found inadequate to prevent the escalation of a near miss to a full blown incident if there is not a sound record on the part of management in enforcing the implementation of these procedures. Management should always be aware of their responsibilities, and statutory duties, to protect employees and others against risks to health and safety arising out of activities at work. Maximum protection can be afforded by careful consideration of the siting, lay-out design, construction, operation and maintenance of marine terminals and equipment and by the careful design of ships and their cargo containment and handling equipment. However, when emergencies arise, and in spite of all that has been done, the statutory duty to protect employees and others and the environment remains a primary management responsibility.

Marine activities are very heavily regulated in terms of construction and equipment standards, operational procedures and emergency planning requirements and because the shipping industry is largely international in nature most of the regulations eminate from the International Maritime Organisation which is the United Nations Agency with special responsibility in this area. The situation is somewhat more complicated when the ship enters port since further regulations will apply to both the ship and terminal which may be both national and local. This heavy weight of regulation can cause confusion particularly at the interface between ship and jetty when cargoes are being transferred and the risk of an incident is at its greatest.

One way in which management can ensure that its safety and emergency policies are being implemented is to conduct regular audits with independent certification. These audits should not be limited to the amount of physical assets but should extend to the measurement of personnel and their compliance with written procedures. Such audit schemes are best set against international standards to increase acceptability by various interested parties and the close relationship between auditing for loss prevention and auditing for quality should be recognised. The principles of loss prevention and total quality management can be very effectively applied to the distribution industries where the potential for loss can be substantial.

Considerations of cost are always an important factor in implementing effective written procedures and emergency plans and in training personnel for implementation. However the cost implications of failure to achieve these objectives can be much more substantial.

THE MARINE CONTEXT

A ship designed for the transportation of dangerous goods, often in bulk, presents some particular difficulties in emergency planning. The close proximity between cargo tanks, cargo handling facilities and accommodation denies to the shipping situation the separation distances between these facilities which would normally apply on the shore side. In the case of dangerous goods on containerised ships or general cargo ships separation distances between cargoes which may be incompatible are also often minimal because of space restrictions in cargo areas.

When potentially hazardous cargoes are transferred in bulk, the ship becomes an integral part of the shore facility and it is during this time that the greatest risk of an incident arises.

Whilst marine emergencies are usually the result of a malfunction of a normal operating procedure, and as such are not substantially different from any other emergency on the shore side, they may occasionally be precipitated by the intervention of an outside agency such as a severe electrical storm or bad weather to which the marine industry is particularly susceptible, or they may result from deliberate acts of terrorism or war where the shipping industry often finds itself in the front line.

INTERNATIONAL AND NATIONAL TRAINING REQUIREMENTS

The Ships

Specialist training courses in the safe handling of bulk liquids have been available to the shipping industry since the late seventies. Dangerous Cargo Endorsements to Certificates of Competency became mandatory for responsible officers on the 1st of April 1984 when the International Maritime Organisation's Standards of Training, Certification and Watchkeeping Convention entered into force. This convention defines responsible officers as the Master, Chief Mate, Chief Engineer, Second Engineer and Cargo Officer and the convention applies to three tanker types namely, Petroleum, Chemical and Liquefied Gas. Besides the normal qualification requirements for senior officers to have Certificates of Competency these officers must comply with the following additional requirements to obtain a Dangerous Cargo Endorsement:

1. six months previous experience onboard the appropriate ship type carrying the particular endorsement cargo.

2. satisfactorily complete a one week Dangerous Cargo Endorsement course.

In the case of a liquefied gas carrier safety course the following topics would be considered during one week of intensive training:

Applied Science
Potential Hazards
Ship's Characteristics and Cargo Containment
Regulations and Codes of Practice
Cargo Handling Systems
Ship Operations
Terminal Operations
Safe Practices and Safety Equipment
Emergency Procedures/Case Studies

It will be seen that emergency procedures and case studies, whilst each important components of course, form only one element in an otherwise crowded timetable and account for approximately 20% of course time. A similiar situation would apply to chemical and petroleum tanker courses.

Such courses are required to be assessed and approved by the appropriate maritime administrations and when so approved certificates issued should be accepted by the maritime administrations of other flag states. (Ref. 1)

In the case of dangerous goods in packaged form similar training is available to the industry for responsible officers however this is not made mandatory by Convention although it is recommended in Annex II of the International Maritime Organisation Resolution A.537 (13) adopted on the 17th November 1983. The course content follows a similar pattern to that described above for liquefied gases in bulk and once again the time allocation to emergency procedures and case studies is similar.

The Shore

Whilst the International Maritime Organisation frequently makes recommendations regarding operational arrrangements and emergency procedures at marine terminals, such recommendations are not mandatory since the marine terminal normally lies within territorial limits and is within the national boundary of a particular state. Consequently, whilst the training arrangements for merchant navy personnel has been standardised, this is not the case for marine terminal personnel and there is considerable variation in the training standards to be found even within the same company or country.

In the United Kingdom, the Health and Safety Executive has recently introduced regulations governing the Movement and Handling of Dangerous Substances in Harbour Areas (Ref. 2). This Statutory Instrument has made a major contribution towards the harmonisation of local Port Authority bye-laws governing the movement of dangerous goods in harbour areas within the U.K. Prior to the enactment of this legislation each Port Authority had published its own local bye-laws and this presented problems for ships moving from port to port as a great variation in these regulations could be encountered. Further, these new regulations refer to the most recent international standards emanating from the

International Maritime Organisation and important international codes of practice such as:

The Tanker Safety Guide for Liquefied Gas (Ref. 3)
The Tanker Safety Guide for Chemicals (Ref. 4)
The International Safety Guide for Oil Tankers and Terminals, 3rd Edition (Ref. 5)
The Safety Guide for Terminals Handling Ships Carrying Liquefied Gases in Bulk (Ref. 6)
The International Maritime Dangerous Goods (IMDG) Code (Ref. 7)

In Part 4 of the Dangerous Substances in Harbour Areas Regulations 1986 the employer is required to ensure that personnel are adequately trained and that records are kept of such training but the training itself is not specified. In Part 7 of these regulations, the Harbour Authority is required to "prepare and keep up to date, after consulting the emergency services and other bodies which appears to it to be appropriate, an effective emergency plan for dealing with emergencies which involve, affect or could affect dangerous substances that are brought into or handled in the harbour or harbour area as the case may be". And similarly in Part 7, the berth operator is required to "ensure that at all times when a vessel loading, carrying or unloading a dangerous substance is at the berth and at any other time when there are risks from dangerous substances (a) means of rapid communication with emergency services are available and (b) adequate means of escape from that berth are provided for use in an emergency and (c) that the Master of the vessel is notified of emergency arrangements at the berth and the means by which the alarm can be raised".

Many other countries have made similar arrangements to replace local port regulations, which deal with the movement of hazardous goods and emergency planning, with national regulations. But the difficulty remains for marine personnel in that much variation from port to port still exists in the approach to emergency planning. There is still much room for further harmonisation.

TRAINING IN EMERGENCY PROCEDURES

It is clear that, and most competent authorities agree, there is great advantage in training personnel from ship and shore together on the same training courses since emergencies are most commonly encountered at the interface between ship and shore when cargo is being transferred. Difficulties can arise however since the regulations which require such training originate with differing regulatory bodies. It has nevertheless been the experience of the Centre that this view is largely shared by the marine and terminalling industries and there is evidence for it in the fairly high proportion of shore personnel who attend tanker safety courses.

Taking as a typical example the emergency procedures section of the Syllabus for a Liquefied Gas Carrier Safety Course as required by the International Maritime Organisation for Dangerous Cargo Endorsements, the following topics would be dealt with:

Shipboard Emergency Plan, Organisation and Planning
    Ship/ship communications
    Ship/shore communications

Typical port emergency plan and organisation

Stranding, collisions and potential subsequent release of toxic and/or flammable vapours

  Actions to be taken in the case of

    Failure of hard arms/hoses
    Ship breaking off the jetty
    Cargo overflow
    Cold spot
    Cargo spillage into void spaces due to tank failure
    Crack in cargo lines ship and shore

    Personal Emergencies
    First Aid and Rescue techniques

    Case Studies

A suitable presentation of this material can be found in Chapter 10 of "Liquefied Gas Handling Principles on Ships and in Terminals" (Ref. 8) and in "A Guide to Contingency Planning for the Gas Carrier at Sea and in Port Approaches" (Ref. 9).

CASE STUDIES

The use of case studies so as to improve the effectiveness of training in emergency procedures is now a common practice. The approach encourages discussions between course participants and helps ship and shore personnel to appreciate some of the difficulties which apply to the other parties unique situation. In the author's view these case studies should be based on actual incidents but should not provide so much detail as to allow these incidents to be identified. Furthermore, an uncluttered approach allows participants to move on to problem solving without becoming immersed in the detail of the incident. Participants should be encouraged to consider and discuss:

1. The hazards which arise from such an incident
2. What action should have been taken to prevent the incident
3. The actions to be taken given that the incident has occurred

Consideration of case studies by course participants encourages students to draw on all the other topics considered in the course and apply this information in an intelligent way during group discussion and final presentation to the class as a whole. This sharing of experience allows all to benefit from the experience of those who have had the misfortune to participate in the incident in the first place.

THE DISTANCE LEARNING APPROACH

The distance learning approach to training in the shipping industry has been applied for many years. Formerly known as correspondence courses, distance learning today is a multi-media approach to training which makes use of specially tailored teaching material designed for learning at a distance with back-up tutorial support and assignments, and including audio and video programmes. A recent innovation has been the development by the Centre of distance learning in the transportation of dangerous goods by sea. Whilst the training package is comprehensive and deals with all aspects of the transportation of dangerous goods in the marine context a substantial element is devoted to safe practices, safety equipment and emergency procedures. Open learning is particularly suited to the shipping and marine terminalling industries whose personnel are scattered throughout the world and who may not have the opportunity to attend the few specialist seminars which are available each year because of economic or logistical constraints. There are obvious disadvantages however in relation to emergency procedures for inter change of views and experience is necessarily restricted to between the tutor and the pupil and problems of the ship/jetty interface cannot be dealt with so effecitvely.

MARINE EMERGENCY PROCEDURES

The emergency procedures which should be applied to incidents involving bulk liquids can be found in the appropriate tanker safety guides (Refs. 3, 4 and 5). Typical of these is the emergency procedure for oil tankers and terminals contained in Chapter 13 of the International Safety Guide for Oil Tankers and Terminals 3rd Edition. Here can be found details regarding the preparation of plans both by the terminal and by the tanker to meet an emergency that may in any way concern the cargo or cargo handling, as well as the immediate action to be taken in such an emergency. Particular attention is paid to the procedure to be followed and the action to be taken in the event of a fire, because this is potentially the most extreme kind of emergency likely to be encountered, but much of the guidance is applicable in other circumstances. Topics dealt with include the following:

General Arrangements

Terminal emergency plan

Preparation, control, communications, communication systems, fire fighting equipment plan, access to equipment, vehicle movement and control, use of municipal and port services, port authorities, police and fire services, pilots, tugs, rescue launches, medical facilities, harbour authorities and vessel traffic control centres, emergency removal of a tanker from a berth, training and drills.

Tanker Emergency Plans

Preparation, emergency organisation, command centre, emergency party, back-up emergency party, engineering group, preliminary action, ships fire alarm signal, fire fighting equipment plans, inspection and maintenance, training and drills.

Fire on a Tanker at Sea or at Anchor

Fire on a Tanker at a Terminal

Action by ship's personnel, action by terminal personnel.

Fire or Explosion on a Berth

Action by vessels, action by vessels at other berths, jettisoning of cargo.

In the case of dangerous goods, the IMO Emergency Procedures for Ship's Carrying Dangerous Goods publication is normally referred to in the abbreviated form as "EmS". This stands for Group Emergency Schedule (Ref. 11). These procedures are referred to in the general index of the IMDG Code (Ref. 7) and are the procedures to be followed in the case of incidents or accidents involving dangerous substances. The EmS schedules are clear, easy to read and understand. They lay down what could be termed as "first aid" information on handling an emergency situation involving hazardous substances. The recommended emergency procedures and actions refer to substances and articles listed in the IMDG code. These procedures should be followed in conjunction with the information given in the IMDG and the International Maritime Organisation Medical First Aid Guide for use in Accidents Involving Dangerous Goods. (Ref. 12).

The Group Emergency Schedules are laid out in five sections and some have an additional information section.

Section 1	Group Title and Number
Section 2	Special Emergency Equipment to be carried
Section 3	Emergency Procedures
Section 4	Emergency Action and Action to be taken in the event of spillages and in the event of fire
Section 5	First Aid Treatment

Where there are variations in the recommendations for specific substances, such variations are specified under each emergency schedule.

Any source of information list for incidents involving dangerous goods in the marine context would be incomplete without reference to the Chemical Hazard Response Information System (CHRIS) which is produced by the U.S. Coast Guard and designed to provide information for use by Coast Guard personnel who are responsible for decision making at the scene of a chemical emergency (Ref. 13). CHRIS also provides much information that can be used to achieve better safety procedures and to prevent accidents. CHRIS consists of the following components:

Four handbooks of manuals

A Condensed Guide to Chemical Hazards
Hazardous Chemical Data Manual
Hazard Assessment Handbook
Response Methods Handbook

Hazard Assessment Computer System (HACS)

This is a computerised version of the hazard assessment handbook.

SPECIALIST FIRE FIGHTING TRAINING

The International Maritime Organisation requires that all marine personnel undergo practical firefighting training related to the marine situation. This requirement however does not extend to specialist ships and cargoes such as liquefied gases, chemicals, petroleum or dangerous goods in packaged form. Although short practical fire fighting courses for specialist ships and specialist cargoes have been available for some years the demand for these courses is weak since the requirement for training is not mandatory but only recommended by the International Maritime Organisation. Although some national maritime organisations have taken steps to require such training this is by no means widespread and until such training is made mandatory in the international context there can be little hope for improvement.

EMERGENCY PROCEDURES AT THE SHIP/JETTY INTERFACE

The ship/jetty interface is the area of greatest risk of incident occurring since cargo is being transferred, in the case of bulk liquids, from one containment system to another. Since the volumes of cargo being handled are also large there is the possibility of major loss arising from fire, explosion or the large scale release of hazardous materials to the atmosphere. Most ports have emergency plans which attempt to make maximum use of the combined resources of the ship, terminal and external services to:

effect the rescue and treatment of casualties
safeguard other people
minimise damage to property and the environment
contain and bring the incident under control
preserve relevant records and equipment for subsequent enquiry

The Port Authority is responsible for placing a copy of the "Notice to Masters" on board all vessels which are at anchor, moored at buoys or underway within the area of their jurisdiction. This would normally set out frequencies to be used for communications and details regarding methods of obtaining assistance in case of fire or other emergency.

A suitable emergency plan for the port should include a communications plan not only for the shore side agencies such as fire department and port authority etc. but should also indicate communications arrangements between ship and jetty, ship and other ships, and the ship and Port Authority.

A major emergency will require the employment of outside resources to handle it effectively. Available resources may include:

> Emergency services such as fire, police, ambulance and hospital services, Port Authority, inspectors from the Maritime Administration and Health and Safety Exeutive and possibly the Local Authority and Coast Guard.

The emergency plan must clearly set out the agreed action to be taken by each party and each authority is then responsible for issuing its own detailed instructions within the general provisions of the plan.

All plans should be tested at regular intervals to check efficiency and practicability and after each exercise the plan should be reviewed. It is essential to include ships in these exercises so as to highlight, for their mutual benefit, any inadequacies in the emergency plans. Occasionally, the exercise incident should originate on the ship and on these occasions, it is important that costs which arise out of the delay of the ship are shared between interested parties.

It will be clear that training arrangements for these various interested parties will be separate and may be quite different. The ship may not be familiar with the facilities available at the port/terminal and therefore a sound emergency plan is all the more imperative if the emergency is to be dealt with effectively. These emergency plans should be made available to the ship at the earliest opportunity so that some familiarisation might be possible. All too often these emergency plans appear to exclude the ship despite the fact that most incidents occur on board and first aid action will be expected to be applied by ship's personnel at least in the first instance.

For these reasons an integrated approach to training, on the part of all the interested parties which may become involved in an emergency procedure at the ship/jetty interface, would be most desirable.

PREVENTION IS BETTER THAN CURE

A ship or terminal which is operated in an efficient manner with well trained personnel will always present a lower risk of incident and ways in which this might be achieved are well worth examining.

Operating procedures should be written down and adherance to these operating procedures should be enforced by management.

Checklists should be used to assist personnel in following procedures and compliance with these checklists should again be rigorously enforced by management.

Management should institute auditing procedures to check not only for defects in equipment but also to measure people and their compliance with the written procedures. These auditing schemes should ideally be based on international standards such as those promulgated in the International Safety Rating System (Ref. 14). This system recognises the full importance of the human factor in relation to loss control and puts proper emphasis on management's responsibility to enforce written procedures. These procedures should not be limited to the normal operating conditions but should extend to and include the procedures necessary for dealing with emergencies which will always arise despite our most strenuous efforts to avoid them.

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ASHLAND'S DIESEL FUEL SPILL:
A CASE STUDY IN CRISIS MANAGEMENT

by J. Dan Lacy

Vice President, Corporate Communications
Ashland Oil, Inc.

On January 2, 1988, a 4 million gallon storage tank at Ashland's terminal at Floreffe, Pa., was being filled with diesel fuel. At about 5:00 p.m., the tank ruptured.

In less than a second, 3.9 million gallons of diesel oil erupted in a tidal wave and much of it overflowed surrounding dikes. Initially undetected, about 713,000 gallons of the fuel escaped into the Monongahela River through a nearby storm drain.

An emergency, an accident can happen to anybody, anywhere. How well you react depends on how well prepared you are. How much it damages your company is determined to a large extent by the public's perception of the speed, competence, and openness of that response.

In a very real sense, public perceptions become reality. If people have only rumors to go on, or if they feel that information is inaccurate, they will fear the worst. Once those opinions are formed, they are almost impossible to change.

In a time of crisis, there are four steps management must take to control the situation -- and chart the course of the company's future:

o First, gain control of the situation, whatever it is. That is, put out the fire, fix the equipment, clean up the mess.

o Second, make it right; tangibly demonstrate genuine concern for damages, injuries, inconvenience.

o Third, while all this is going on, get the facts out to the public as quickly and accurately as possible.

o Finally, to keep it's credibility, a company must act to ensure that the accident doesn't happen again. This means working with public officials, industry groups and independent investigators.

These points are illustrated by our incident at Floreffe.

To begin, let me give you a videotaped overview of what happened, and what we did.

(VIDEOTAPE)

NEWSPERSON, KDKA-TV, Pittsburgh - Jan. 2

Police are telling us a very large diesel fuel storage tank has ruptured and is leaking...

NEWSPERSON, ABC Evening News - Jan. 4

The Monongahela River is laced with floating booms as workers try to net the huge spill of nearly two million gallons of diesel fuel dumped into the river Saturday...

NEWSPERSON, NBC Nightly News - Jan. 4

The oil slick stretches 85 miles, 6 inches deep along the Monongahela River and into the Ohio River...

NEWSPERSON, Unidentified Station

And for many of you, the water has just dried up...

John Hall, Ashland Oil Chairman

I want to apologize to the people of the Pittsburgh area for the inconvenience they have experienced as a result of this incident.

The company expects to pay for the cost of cleanup and to reimburse appropriate government agencies for the reasonable expenses they have experienced in connection with this incident.

ANNOUNCER

The facts are now more clear. A storage tank at Ashland Oil's product terminal near Pittsburgh, Pennsylvania ruptured. The surrounding dikes were unable to contain the sudden rush of diesel fuel -- and 715-thousand gallons found its way into the Monongahela River, disrupting water service in a 3-state region.

Ashland's assistance to the affected areas was swift -- committing whatever resources were needed. Ashland's on-site management team coordinated cleanup efforts. Among the company's efforts:

Professional clean-up companies were quickly hired and put in place.

The company provided vacuum trucks to collect oil from the river and the dike area.

Ashland provided deflection barges, skimmer barges, booms and a corporate helicopter which was used to track concentrations of oil in the river. The company also provided barges filled with water to affected cities which requested it. And boats used to track and analyze the spill were made available to federal and regional agencies.

Ashland's personnel worked around the clock -- assisting with the cleanup and maintaining constant contact with state and local water officials, as well as the EPA, Coast Guard and other government groups. Once water service was restored to Pennsylvania communities, news coverage turned downstream.

NEWSPERSON, CNN - Jan. 6

The pollution is just about Wheeling, West Virginia right now and is expected to roll past that town sometime tomorrow..

NEWS ANCHOR, NBC Nightly News - Jan. 8

The town of Steubenville, Ohio has declared a water emergency because its Ohio River water intake has been fouled by millions of gallons...

ANNOUNCER

As the oil slick continued down the Ohio River, news coverage began to focus on Ashland's responsiveness and candor.

NEWS ANCHOR, WPXI-Pittsburgh - Jan. 8

Well, Ashland Oil made good on its promises to pay the bills for the spill, today giving a check to the county for more than $200,000. Commission Chairman Tom Forrester accepted the payment of $210,000 for payroll, overtime and materials the county has tallied so far. Forrester praises Ashland for its quick response on the check saying the county is still waiting for payment for other disasters that happened a long time ago.

WQED-Pittsburgh - Jan. 10

Lt. Gov. Mark Singel of Pennsylvania

I will say that Ashland has been helpful in the cleanup. They've been forthcoming with the information about the tank itself and they have thus far been willing to assume their share of all of the financial responsibilities.

MacNeil/Lehrer Report - Jan. 5

James Seif, U.S.E.P.A.

The company has done a first rate job of responding. They have used all of the same contractors we would use if we would have called them in. They've done all the same things we would do.

ANNOUNCER

The print media, while acknowledging the seriousness of the spill, applauded the company's actions.

In the Huntington Herald-Dispatch -- "We can't help but say well done to John Hall, Ashland's no-nonsense chairman and chief executive officer."

In the Louisville Courier-Journal -- "In taking the risk to say that Ashland held itself accountable for what happened, he has joined Lee Iacocca and very few other top executives in America who can now speak for their companies and know they will be listened to by the press and the public."

The company's efforts were not limited to clean up operations. Ashland set up a Pittsburgh service office headed by Corporate Vice President Philip Block. And to further assist those individuals with claims against Ashland, it was announced that Crawford & Company, a nationally recognized claims adjusting firm, also opened an office in Pittsburgh. Crawford & Company, which has experience in handling oil spill claims, also established an office in Steubenville, Ohio.

To assess the environmental impact of the spill, Ashland has awarded a grant of $250,000 to the University of Pittsburgh's Center for Hazardous Materials Research. The Center is conducting an independent study of the effects of the spill into the Monongahela and Ohio Rivers.

WSAZ-Huntington/Charleston, WV - Jan. 22

Dr. Ed Berkey, Univ. of Pittsburgh

Based on other oil spills that the study has looked at and the ability of biological systems to recover and regenerate themselves, we think that there will not be any significant long term impacts.

John Hall, Ashland Oil Chairman, Shareholders Meeting - Jan. 28

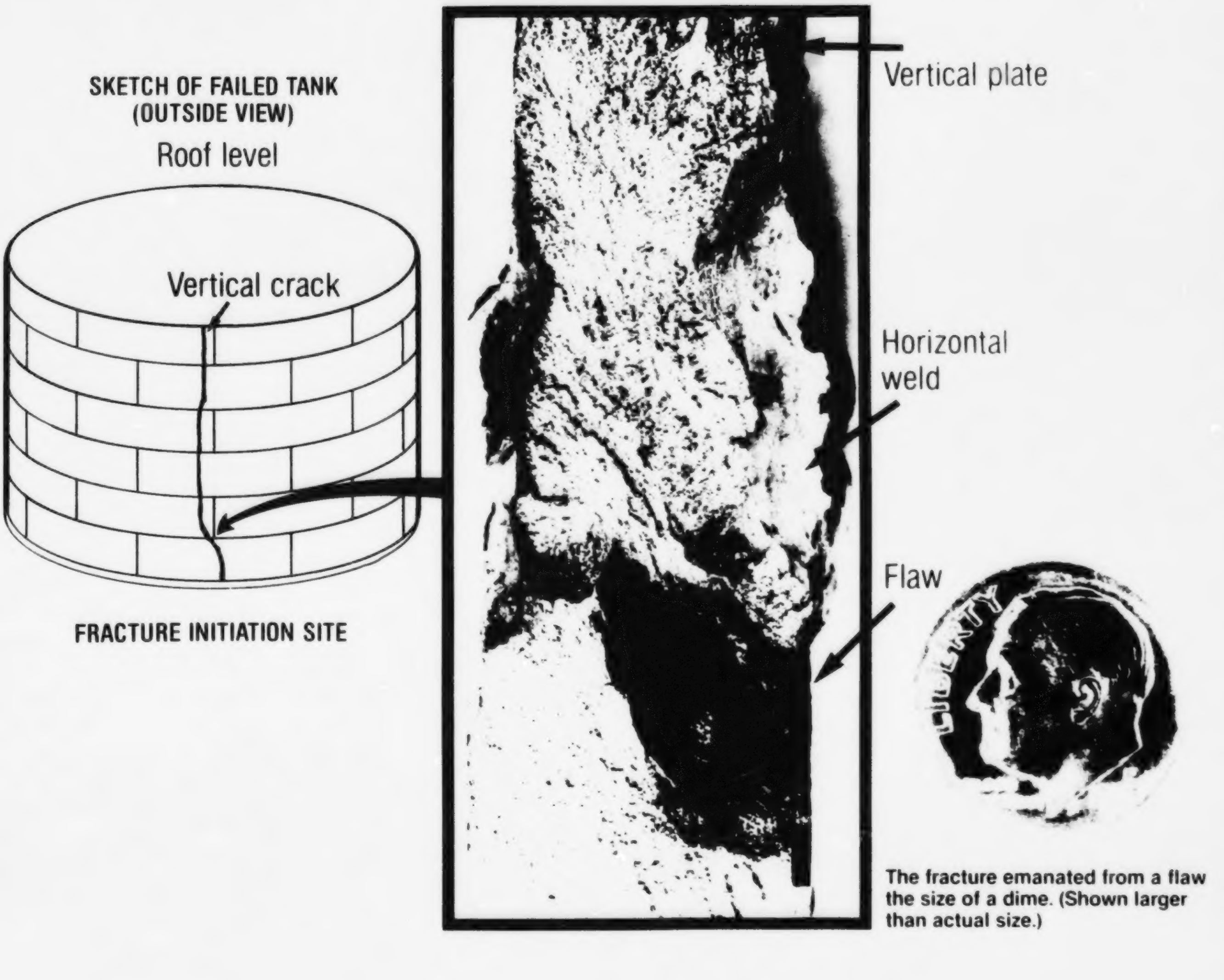
Ashland Oil has operated in the Ohio River Valley for 64 years without an incident of this type. We're proud of our record, and we're embarrassed that this unfortunate incident has occurred. Now the plume is largely dissipated, returning our attention to investigations to determine what caused the incident and to organizational and procedural changes that will help us make sure an incident of this type is never repeated.

ANNOUNCER

On May 26th, Ashland Oil released the report conducted by Battelle Memorial Institute which detailed the cause of the storage tank collapse. According to Battelle's investigations, the tank failure was caused by a brittle steel fracture emanating from a dime-size flaw in the tank's bottom course steel plate. Stress and cold temperatures contributed to the fracture. Ray Mesloh, Battelle project manager, headed the investigation.

Ray Mesloh, Battelle Project Manager, at news conference - May 26

We did find out a couple of things about this flaw. One, it was produced by an oxy-acetylene torch. The reason for that is explained in your handout, but I'll tell you that we found iron carbide on the surface and a heat affected zone around the flaw that can only be produced by a flame cut. We also determined that this flaw was in the base plate material of the tank. It was not in a weld, but below the weld. And we have determined that


SKETCH OF FAILED TANK
(OUTSIDE VIEW)
Roof level
Vertical crack
FRACTURE INITIATION SITE
Vertical plate
Horizontal weld
Flaw
LIBERTY

The fracture emanated from a flaw the size of a dime. (Shown larger than actual size.)

the flaw was in the plate prior to the initial construction of the tank at Whiskey Island, Ohio.

ANNOUNCER

To ensure that an accident of this type doesn't happen again, Ashland has made the Battelle report available to industry and the public. The company also conducted a comprehensive review of its facilities and has made appropriate procedural and organizational changes.

In addition, ERT, an environmental consulting firm, has been retained to conduct detailed studies of the rivers and affected wildlife. From the beginning of the incident, Ashland's comprehensive action and responsiveness has been motivated by the company's definition of responsibility.

John Hall, Ashland Oil Chairman

I think you have to look at it in human terms. You have to try to do what's right, and that's what we're trying to do.

(END VIDEOTAPE)

Now, let me flesh out each of the four elements:

- Getting Control
- Making it Right
- Getting the Facts Out
- and Making Sure It Doesn't Happen Again; or applying "A Pound of Cure."

Getting Control

The force of the wave of oil knocked out power and telephone service at the terminal. The temperature was seven above zero. It was dark. The physical situation was hectic and tense and miserable.

The terminal people made all the proper notifications. Emergency response personnel evacuated about 200 households for a few hours until authorities were sure conditions were safe. It took two examinations of the Monongahela River, however, before the presence of oil was discovered about 8 p.m.

Ashland then called OH Materials in Findlay, Ohio, to begin the containment and cleanup. They arrived about 7:00 a.m. Sunday.

There was another complication. As the oil churned over two nearby dams, it emulsified. Eventually it extended from shore to shore and top to bottom of the Monongahela, and into the Ohio. Water service to 22,000 people in Greater Pittsburgh was shut off.

Ultimately, we used 20,000 feet of booms and every available technique. Primary cleanup efforts were remarkably successful. We recovered 204,000 gallons of diesel oil -- about 30 percent of the amount that went into the river. (The EPA considers 20 percent very good.)

Making It Right

In the middle of such an emergency, crucial decisions must be made under extraordinary pressures. The key to making those decisions correctly is to know what the options are. The decisions in our case were made by a team led by Ashland Chairman John Hall. By Monday, after consulting with senior managers and employees on the scene, a comprehensive plan of action had been developed.

On Tuesday morning, Hall implemented the plan before the press in Pittsburgh. He apologized for the inconvenience to the public, accepted responsibility and promised to pay for all reasonable costs associated with the incident, and promised a full report on the cause as soon as it was available.

The guiding principle was Hall's decision to accept responsibility. On that basis we offered assistance to cities downstream on the Ohio River. We talked to officials in more than 17 cities from Pittsburgh to Louisville. We spent whatever it took to get water to everyone who needed it.

You saw on the tape the actions we took with Battelle Institute, the University of Pittsburgh and ERT to study and report -- to us and the public -- on the cause and the damage.

This openness produced much goodwill -- and I believe the filing of fewer claims than might have been expected.

The claim total is now over 6,000, most of them reasonable. (There were some exceptions, such as the television station that submitted a bill for the cost of covering the spill.)

Thus far, Ashland has paid out $17 million for cleanup costs and claims. We have paid more than 85% of the individual claims.

Getting the Facts Out

Ashland's management team dealt first with a decidedly (and understandably) hostile reaction from the public and press in the Pittsburgh area, hence John Hall's Tuesday news conference.

Media Relations Manager Roger Schrum arrived on the scene within hours of the spill, and worked with press and public relations staffs of the EPA, Coast Guard and DER.

Meanwhile, Administrative Vice President for Government Relations, Mac Zachem, met with key public officials in Pennsylvania.

At the same time Ashland's Washington staff was meeting key congressmen and senators, and the state government relations staff met with officials in Ohio, Kentucky and West Virginia, the states affected by the spill.

Ashland's New York office made key contacts on Wall Street, a critical audience considering the potential impact on the company.

In Ashland, the Corporate Communications Department handled telephone interviews, monitored media coverage and coordinated activities. We beefed up the staff with communications people from other company divisions, plus outside experts.

The latest information was provided to Ashland's 40,000 employees through electronic mail and bulletin board postings. That was critical, since informed employees could effectively spread accurate information and squelch rumors. They did.

A key to the success of this effort was Hall's decision to publicly acknowledge any mistakes, as soon as they became known to management. This included some embarrassing facts: the company did not have written confirmation of all permits before construction began, normal welding practices were not followed and the tank was not subjected to a full hydrostatic test in accordance with current API 650 standards. In addition, the steel was from an old used tank, moved and reassembled from a closed company facility in Cleveland.

What we didn't want to happen was for some outside investigation to reveal unpleasant information. Then, charges of coverup could undermine a company's credibility overnight.

By being proactive, people were able to get a sense of the genuine concern of Ashland's management. As a result, much of the natural public anger and frustration was dissipated.

Five days after the spill, the Associated Press carried a national story on the spill which the Cincinnati Enquirer covered with a headline that said "Ashland Chief's Honesty Wins Praise."

The approach paid off on Wall Street as well. Ashland stock lost only about $3.50 following the spill and was trading at its year-opening level -- just above $57 -- in less than 4 weeks. By the time the stock split later in the year, the price had risen above $72 a share.

A Pound of Cure

At the company's annual meeting in January 1988, Hall announced a program to review the permits and integrity of all company tanks to assure the public that such an incident would not be repeated. Further, Hall indicated that all future tank construction would fully comply with the material, welding and testing specifications of API 650.

He also announced that four employees had been reassigned as a result of the incident.

In addition, the company conducted an internal review of policies, procedures, and emergency plans involving other tanks and similar facilities.

Finally, at the end of May, the report from the Battelle Memorial Institute was made public, as you saw on the tape. It identified the cause of the tank failure as a brittle steel fracture, the result of a dime-size flaw in the original steel.

The environmental reports are gratifying. The scientists tell us the long range damage will be minimal.

Co[illegible]sion

Currently, the attention of management is focused on the long process of [illegible]gulatory reviews; we have had the inevitable "One Year After" news st[illegible] ERT and Battelle continue long term studies of the impact of the sp[illegible]

[illegible]ly, however, the cornerstone of this successful crisis management was the [illegible]cly decision to be open and to accept responsibility.

[illegible]t, by quickly taking responsibility -- by being a good corporate citi[illegible] - and by getting information out speedily, Ashland actually earned public trust rather than lost it, and made the best of an unfortunate situation in Pennsylvania.

In closing, I couldn't put it any better than one couple from Pittsburgh who took the time to write to us:

"We are writing to offer a word of thanks for your concern about our evacuation from our home. We were quite frightened for awhile and more than a little inconvenienced due to the spill, but were impressed by the prompt and competent action taken by your company and local authorities.

"We will not be filing a claim as it is our belief that an accident is just that and that all is well that ends well. Again, thank you for your concern and accept our wishes for Ashland's future success as industry is so vital to this area."

THE VALDEZ OIL SPILL INCIDENT

SPEAKER TO BE ANNOUNCED

THIS INCIDENT OCCURRED JUST BEFORE THE TIME OF GOING TO PRESS, AND PROGRAM SPACE WAS SET ASIDE FOR A POSSIBLE PRESENTATION. THE PAPER WAS THEREFORE NOT AVAILABLE AT THE TIME OF PRINTING